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UNITED STATES DEPARTMENT OF AGRICULTURE

DEPARTMENT BULLETIN No. 1260

Washington, D. C. ▼ August, 1924

SORGHUM EXPERIMENTS ON THE GREAT PLAINS

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U. S. DEPARTMENT OF AGRICULTURE

By

H. N. VINALL, Agronomist in Charge of Sorghum Investigations, and
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Office of Forage-Crop Investigations,
In Cooperation with the Office of Cereal Investigations, Bureau of Plant Industry

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By H. N. Vinall, *Agronomist in Charge of Sorghum Investigations,* and R. E. Getty and A. B. Cron, *Assistant Agronomists, Office of Forage-Crop Investigations, in cooperation with the Office of Cereal Investigations, Bureau of Plant Industry.*

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THE SORGHUM BELT.

Most of the experiments described in this bulletin were conducted in the southern half of the Great Plains, a section which, on account of its climatic characteristics, has become the sorghum belt of the United States. Reports of the Bureau of the Census show that a very large percentage of our sorghum acreage is in the western parts of Kansas, Oklahoma, and Texas and the eastern portions of Colorado and New Mexico. (Fig. 1.) The sorghums can also be grown successfully in the Corn Belt and in the Southeastern States, especially for forage. Other crops are relatively more profitable in these sections, however, and the sorghums are, therefore, grown to only a limited extent outside the Great Plains area.

The experimental work with sorghums at the United States Department of Agriculture field stations and the State substations has progressed through cooperation with the Offices of Dry-Land Agriculture Investigations and Cereal Investigations of the Bureau of Plant Industry and the State experiment stations in Kansas and Texas.

The location of the field stations where the experimental data were obtained is indicated in Figure 2. This map is adapted from Figure 1 on page 485 of the Journal of Agricultural Research, Volume XIV (*2*).[1] Very few experiments were carried on at the stations north of

[1] The serial numbers (*italic*) in parentheses refer to "Literature cited," at the end of this bulletin.

Hays, Kans., because the sorghums are of little value in regions that do not have approximately four months of rather high summer temperatures. It has been estimated that the optimum temperature for growth in sorghum is about 92° F. and that the sorghums make only indifferent growth at temperatures lower than 60° F. (*14*). The few experiments at Redfield, Ardmore, and Newell, S. Dak.; Mandan and Dickinson, N. Dak.; and Moccasin and Havre, Mont., have indicated rather definitely that sorghum is not likely to be a crop of much importance in the northern Great Plains. In South Dakota, sorghum may be grown for forage with fair success; but in other parts of this section preference should be given to corn and other crops, such as the small grains, which will thrive at lower temperatures than the sorghums.

Altitude is also a limiting factor in the production of sorghums. The upper limit of their successful production varies with the latitude from about 4,000 feet in Montana to 7,000 feet in southern New Mexico. The western limit of the Great Plains area is the

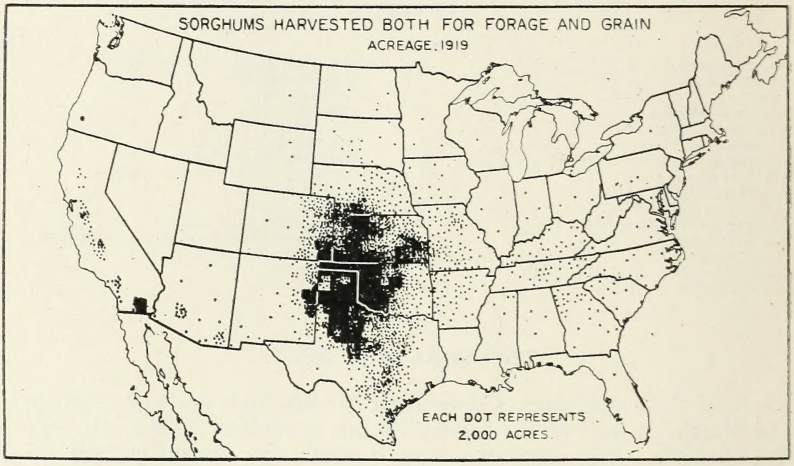

FIG. 1.—Outline map of the United States, showing the distribution of the sorghum acreage in 1919.

5,000-foot altitude line east of the Rocky Mountains and the eastern boundary is the ninety-eighth meridian. (See fig. 2.) The southern half of this area, therefore, is well within the limits of sorghum production.

CLIMATIC FEATURES.

In order to understand fully the results obtained at the different field stations, it is essential to know something of the local climatic conditions. The climate is ordinarily classified as semiarid, and the limiting factor in the southern half of the Great Plains is almost wholly the rainfall, while in the northern Great Plains the temperatures effectually limit sorghum production, as indicated by the distribution of the acreage in 1919. (See fig. 1.)

Three-fourths of the annual rainfall in the sorghum belt is received during the six summer months, April to September, inclusive, as shown in Figure 3.

The distribution of the rainfall is as important as the amount in determining yields. The total annual precipitation varies greatly

from year to year, but if properly distributed it is nearly always sufficient to produce a fair sorghum crop. (See Table 1.) Uncertainty as to when a dry period is coming, however, makes it impossible to adjust the date of seeding so as to avoid the drought or vary the cultural methods to minimize its effect to the degree that would be possible if the wet and dry periods were uniform from year to year.

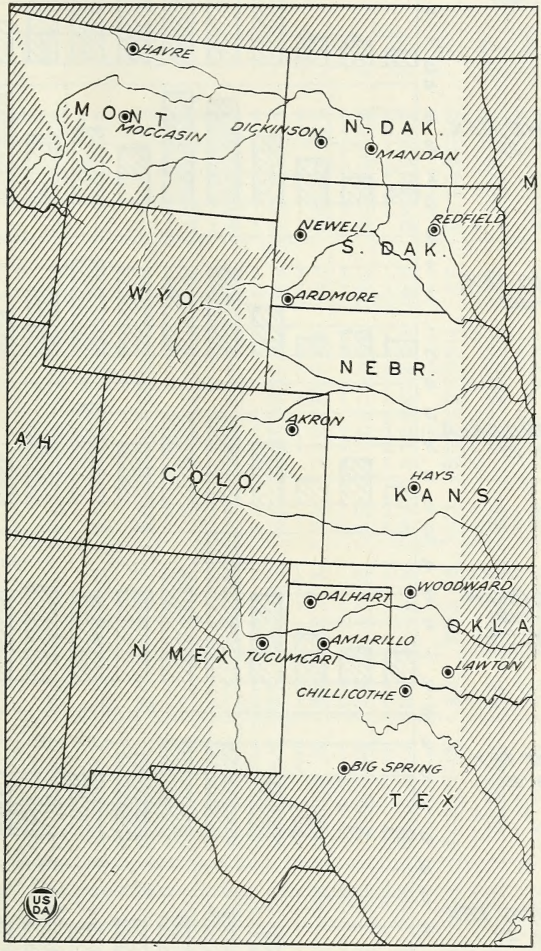

FIG. 2.—Map of the Great Plains area, which includes parts of 10 States and consists of about 400,000 square miles of territory. Its western boundary is indicated by a 5,000-foot contour. The location of each field station within the area is shown by a dot within a circle (⊙).

Associated with the low and unevenly distributed rainfall are relatively high summer temperatures, generally low atmospheric humidity, high wind velocity, and a large proportion of clear days, all of which result in a high rate of evaporation and a decrease in the effectiveness of the rainfall. The monthly, seasonal, and annual precipitation and the seasonal evaporation for each of the eight field stations in the sorghum belt are given in Table 1, for the period of years during which the experiments have been in progress at the

different stations. The term "seasonal" refers to the 6-month period from April to September, inclusive, during which time climatic conditions have an immediate effect on the growing plant. Very

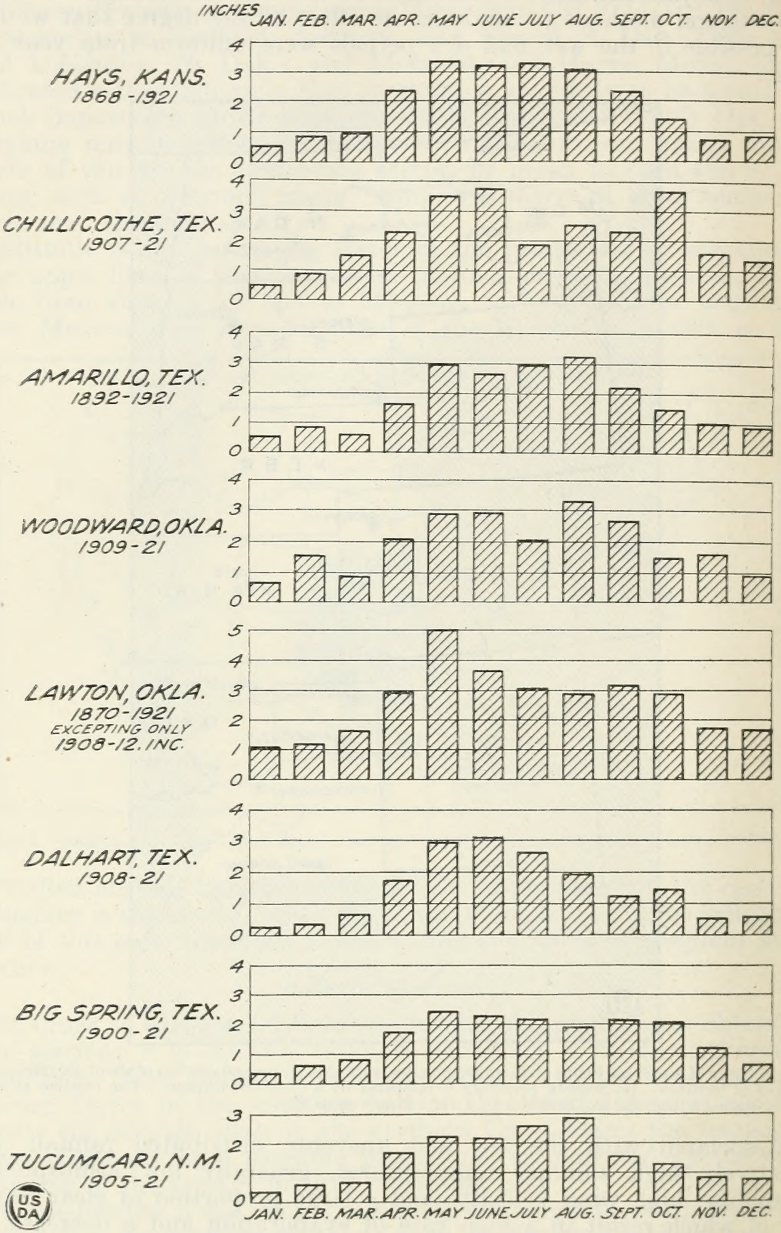

FIG. 3.—Average monthly precipitation at the eight field stations where sorghum experiments were conducted.

few of the plats were seeded before May 15, but rains coming between April 1 and the date of seeding supply much of the soil moisture necessary for germination and early growth.

TABLE 1.—*Monthly, annual, and seasonal precipitation at the eight field stations where sorghum experiments were conducted for the years during which these experiments were in progress, with averages for this period and for the whole period covered by climatic data, together with seasonal evaporation comparisons.*[1]

[T=trace.]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.	Seasonal.	Seasonal evaporation.
Hays, Kans.:															
1914	0.04	0.42	0.15	2.31	2.36	3.39	2.77	2.63	0.60	1.33	T	0.63	16.63	14.06	47.10
1915	.68	1.80	1.74	3.13	6.82	3.97	8.18	4.11	2.44	.93	.30	.04	34.14	28.65	32.79
1916	.53	.15	.31	2.21	1.63	5.88	.36	1.97	1.26	1.14	.02	.61	16.01	13.25	50.20
1917	.11	T	.07	1.96	1.72	2.15	1.46	5.73	1.84	.09	1.64	.15	16.92	14.86	50.47
1918	.80	1.15	1.71	2.49	4.79	.53	3.04	1.76	1.42	2.41	1.10	2.38	23.58	14.03	47.57
1919	T	2.18	.33	4.51	6.85	3.51	1.16	.77	3.32	1.81	1.54	.15	26.13	20.12	41.00
1920	.05	.37	.30	2.04	3.32	1.87	1.89	5.11	1.56	3.58	.73	.46	21.28	15.79	39.78
1921	.49	.10	.49	3.58	2.59	3.67	3.36	3.04	.68	.05	0	.50	18.46	16.92	44.56
Average:															
1914 to 1921	.33	.77	.64	2.78	3.76	3.12	2.77	3.14	1.64	1.42	.67	.61	21.64	17.21	44.18
1868 to 1921	.54	.86	.96	2.31	3.35	3.20	3.27	3.02	2.30	1.45	.75	.84	22.85	17.45	------
Chillicothe, Tex.:															
1913	.35	1.90	1.32	1.77	1.01	2.33	.29	.05	4.21	4.71	2.79	5.51	26.24	9.66	------
1914	T	.30	1.68	2.40	6.16	1.67	1.76	8.47	1.04	1.44	.41	1.28	26.61	21.50	41.11
1915	.34	1.88	1.22	5.13	2.15	6.71	4.07	3.73	3.83	5.07	.15	.53	34.81	25.62	39.67
1916	1.00	T	1.48	3.62	1.02	1.17	.48	1.19	1.77	3.06	1.53	.02	16.34	9.25	53.23
1917	.20	.30	.30	.73	2.33	.34	4.05	1.11	2.06	.35	.82	T	12.59	10.62	55.33
1918	.10	.42	1.56	1.15	.95	4.49	.76	.26	3.35	6.35	2.82	3.44	25.65	10.96	60.25
1919	.23	.76	2.28	5.27	8.79	2.88	1.22	1.41	2.64	13.23	2.24	.29	41.27	22.21	43.39
1920	1.92	.63	1.49	2.41	9.66	1.45	1.39	8.37	3.61	5.42	2.83	.52	39.70	26.89	49.19
1921	.31	1.02	1.20	.69	.67	9.60	.06	2.73	1.52	.03	T	.13	17.96	15.27	53.17
Average:															
1913 to 1921	.50	.80	1.39	2.57	3.64	3.40	1.56	3.04	2.67	4.41	1.51	1.30	26.80	16.89	49.42
1907 to 1921	.43	.90	1.50	2.27	3.49	3.76	1.86	2.54	2.36	3.65	1.59	1.32	25.67	16.28	------
Amarillo, Tex.:															
1913	.11	.55	.59	1.76	1.41	2.32	1.89	.61	4.19	.81	1.98	2.84	18.97	12.09	53.79
1914	.06	.10	.15	.95	4.43	.84	3.07	2.97	1.07	4.46	T	1.17	19.27	13.33	49.27
1915	.72	1.60	1.00	5.05	1.70	1.04	4.14	5.85	4.69	1.55	.18	.13	27.65	22.47	42.80
1916	.36	.02	.57	1.71	.89	2.18	.94	3.82	1.76	2.90	.40	.88	16.43	11.30	54.57
1917	.69	.22	.25	.71	2.49	.83	2.68	6.17	2.05	.34	.59	.04	17.06	14.93	54.72
Average:															
1913 to 1917	.39	.50	.51	2.04	2.18	1.44	2.53	3.88	2.75	2.01	.63	1.01	19.88	14.82	51.03
1892 to 1921	.55	.82	.59	1.67	2.97	2.61	2.99	3.21	2.23	1.48	1.00	.87	20.99	15.68	------
Woodward, Okla.:															
1915	1.17	3.44	1.45	6.53	5.29	2.43	3.14	3.62	5.74	2.36	.55	.06	35.78	26.75	41.66
1916	1.50	.03	.82	1.78	1.70	10.26	0	1.02	2.34	1.71	.75	.60	22.51	17.10	53.93
1917	.20	.20	.10	1.58	1.03	1.37	1.13	6.65	2.72	.05	.67	.01	15.71	14.48	49.87
1918	1.60	.29	2.09	2.22	4.00	1.91	.73	1.35	1.24	3.35	1.53	2.92	23.23	11.45	49.78
1919	.06	1.53	1.94	4.10	4.29	2.22	1.35	1.87	.63	1.85	2.37	T	22.21	14.46	45.32
1920	1.03	.07	.61	1.06	3.40	1.29	4.69	3.00	5.01	2.55	1.32	1.53	25.56	18.45	48.49
1921	2.22	.61	1.33	1.80	1.91	5.78	2.50	5.11	2.94	.01	0	.11	24.32	20.04	50.61
Average:															
1915 to 1921	1.11	.88	1.19	2.72	3.09	3.61	1.93	3.23	2.95	1.70	1.03	.75	24.19	17.53	48.52
1909 to 1921	.68	1.56	.94	2.08	2.88	2.91	2.03	3.33	2.68	1.50	1.61	.91	23.11	15.91	------
Lawton, Okla.:															
1917	.30	.57	1.74	1.28	4.50	1.01	3.02	2.84	.72	.19	1.08	.03	17.28	13.37	51.03
1918	.20	.25	2.16	2.36	1.29	3.08	2.57	1.48	4.18	8.68	1.20	3.50	30.95	14.96	52.40
1919	.54	1.41	2.99	4.60	5.44	4.36	3.71	1.98	1.67	13.78	2.25	.92	43.65	21.76	37.02
1920	1.04	.61	1.84	3.14	7.53	.69	1.88	4.18	2.05	8.78	2.29	.86	34.89	19.47	38.33
1921	1.15	1.47	2.05	2.14	1.30	5.93	2.95	.83	2.13	.03	T	.53	20.51	15.28	38.75
Average:															
1917 to 1921	.65	.86	2.16	2.70	4.01	3.01	2.83	2.26	2.15	6.29	1.36	1.17	29.46	16.97	43.51
1870 to 1921 [2]	1.08	1.19	1.62	2.98	5.00	3.66	3.05	2.88	3.14	2.89	1.74	1.64	30.87	20.71	------

[1] The detailed monthly data for Chillicothe and Dalhart, Tex., Woodward and Lawton, Okla., and Tucumcari, N. Mex., were collected at the field stations; those for Hays, Kans., and Amarillo and Big Spring, Tex., were taken from records of the United States Weather Bureau. The averages which cover a longer period than that included in the monthly data are also very largely taken from Weather Bureau records.

[2] No records for Lawton, Okla., were obtainable for the years 1908–12, inclusive.

TABLE 1.—*Monthly, annual, and seasonal precipitation at the eight field stations where sorghum experiments were conducted for the years during which these experiments were in progress, with averages for this period and for the whole period covered by climatic data, together with seasonal evaporation comparisons*—Contd.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.	Seasonal.	Seasonal evaporation.
Dalhart, Tex.:															
1916	.44	0	.12	1.49	.69	4.11	2.55	3.45	.72	.22	.03	.37	14.19	13.01	55.81
1917	.14	.09	.03	.37	2.70	.93	1.64	2.28	1.28	.31	1.02	0	10.79	9.20	57.40
1918	.27	.05	2.85	.89	4.87	1.23	1.49	1.67	1.49	1.87	.25	1.74	18.67	11.64	54.57
1919	.09	.96	3.18	3.48	2.75	1.88	2.41	3.45	5.12	2.50	1.14	T	26.96	19.09	45.15
1920	.36	.43	.05	.32	3.25	6.81	2.56	1.33	.81	4.49	.34	.08	20.83	15.08	46.24
1921	1.80	.08	.15	.76	3.70	5.82	5.12	.69	.04	.54	0	.26	18.96	16.13	44.47
Average:															
1916 to 1921	.52	.27	1.06	1.22	2.99	3.46	2.63	2.15	1.58	1.66	.46	.41	18.40	14.03	50.61
1908 to 1921	.25	.39	.63	1.75	2.94	3.10	2.58	1.96	1.25	1.46	.51	.55	17.38	13.58	------
Big Spring, Tex.:															
1915	.45	.15	.83	5.75	.44	1.58	3.43	3.26	2.95	1.33	0	.67	20.84	17.41	------
1916	.13	0	1.74	2.12	.14	1.59	2.48	4.31	.87	1.30	1.01	.10	15.79	11.51	58.13
1917	.28	0	.03	.97	.61	.98	.73	.17	.79	0	.12	0	4.68	4.25	67.79
1918	.60	.73	.09	.10	1.19	3.53	.16	.24	1.66	1.99	.74	1.32	12.35	6.88	65.92
1919	.57	.06	3.06	1.45	1.43	8.28	.95	3.60	7.43	6.31	.78	.09	34.01	23.14	50.89
1920	1.97	.20	.12	.08	5.32	1.33	.91	6.30	.69	1.95	2.22	.20	21.29	14.63	53.44
1921	.25	.90	1.15	.11	3.69	2.77	.45	.85	.71	.23	T	T	11.11	8.58	60.61
Average:															
1915 to 1921	.61	.29	1.00	1.51	1.83	2.87	1.30	2.68	2.16	1.87	.70	.34	17.15	12.34	59.46
1900 to 1921	.42	.60	.79	1.67	2.48	2.28	2.14	1.97	2.12	2.04	1.19	.61	18.31	12.66	------
Tucumcari, N.Mex.:															
1914	.30	.40	.50	2.52	5.24	2.81	3.90	1.06	.72	3.48	T	1.31	22.24	16.25	49.92
1915	.66	.98	.90	4.00	1.59	.71	3.13	2.28	2.94	.67	T	.27	18.13	14.65	52.50
1916	.70	0	.09	1.55	.56	.63	.98	4.43	.56	.78	.29	.32	10.89	8.71	58.90
1917	.31	.11	.12	.32	1.82	.90	.74	6.11	2.74	.16	.62	.04	13.99	12.63	63.46
1918	.10	.13	.21	1.14	.21	.80	2.54	1.02	2.85	2.60	.51	2.00	14.11	8.56	64.68
1919	.04	.32	3.69	3.61	5.84	6.39	3.16	2.53	4.16	2.31	.51	.93	33.49	25.69	45.79
1920	.76	.15	.34	.20	2.55	3.91	1.52	1.48	1.44	3.68	.49	0	16.52	11.10	48.85
1921	1.11	.32	.83	T	8.63	5.88	3.56	1.95	.75	.21	0	0	23.24	20.77	48.10
Average:															
1914 to 1921	.50	.30	.84	1.67	3.31	2.75	2.44	2.61	2.02	1.74	.30	.61	19.08	14.80	54.03
1905 to 1921	.36	.58	.70	1.68	2.17	2.17	2.59	2.82	1.55	1.28	.79	.71	17.40	12.98	------

The length of the frost-free period and the prevalence of effective growing temperatures (those above 50° F.) are important factors in sorghum production. The frost-free periods at different field stations are shown in Figure 4; also the earliest and latest dates of the last killing frost in the spring and the first killing frost in the fall.

Comparison of the average frost-free periods at these different stations with the average growing periods required for the earlier sorghum varieties indicates that in most instances these early varieties should mature at even the most northern stations; but the low temperatures that generally follow the last frost in the spring and precede frost in the fall retard the development of the sorghum so much that it does not mature within the time required for completing its growth farther south. Where such varieties as the Dakota Amber do mature, the yields are so low that their forage value is inferior to that of corn or only slightly better. For this reason the sorghums have remained unimportant in the northern Great Plains, even though the need of such a drought-resistant crop in that section is generally recognized.

SOILS.[2]

The soils of the sorghum belt are for the most part sufficiently fertile to produce heavy crops of sorghum whenever there is an adequate rainfall. At most of these stations the soils have not been defined and identified; an accurate description is therefore impossible.

At Hays, Kans., the soil is similar to the Holdrege soils in Phelps County, Nebr. The soil seems to be as typical a black earth, or chernozem, as any soil in the United States. The first 4 inches is

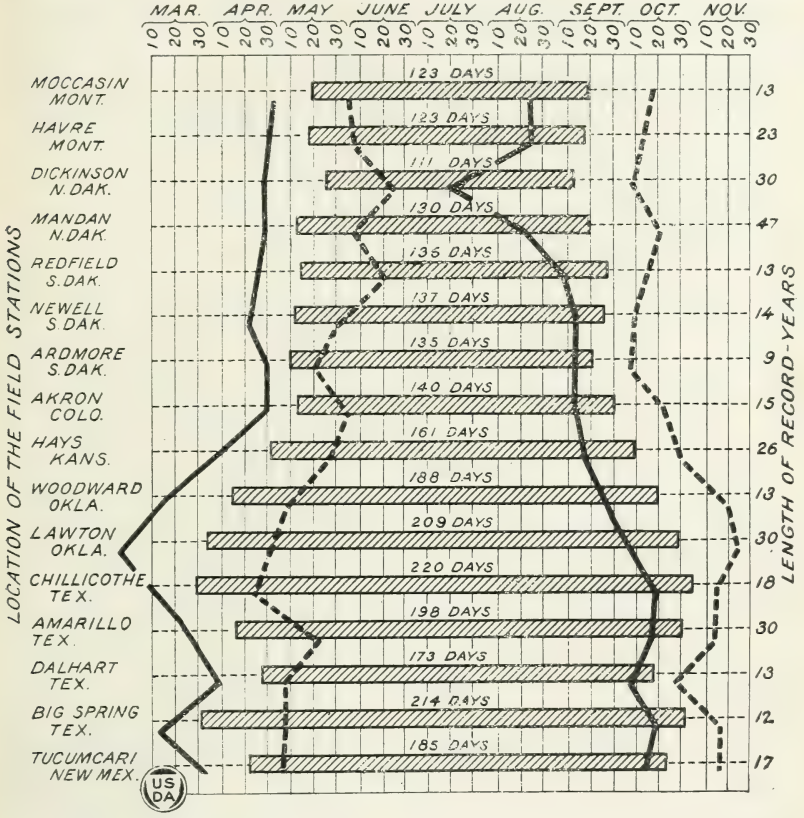
MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV.
10 20 30
LOCATION OF THE FIELD STATIONS
LENGTH OF RECORD-YEARS
MOCCASIN MONT. 123 DAYS 13
HAVRE MONT. 123 DAYS 23
DICKINSON N.DAK. 111 DAYS 30
MANDAN N.DAK. 130 DAYS 47
REDFIELD S.DAK. 136 DAYS 13
NEWELL S.DAK. 137 DAYS 14
ARDMORE S.DAK. 135 DAYS 9
AKRON COLO. 140 DAYS 15
HAYS KANS. 161 DAYS 26
WOODWARD OKLA. 188 DAYS 13
LAWTON OKLA. 209 DAYS 30
CHILLICOTHE TEX. 220 DAYS 18
AMARILLO TEX. 198 DAYS 30
DALHART TEX. 173 DAYS 13
BIG SPRING TEX. 214 DAYS 12
TUCUMCARI NEW MEX. 185 DAYS 17
USDA

FIG. 4.—Diagram showing the average frost-free periods and the earliest and the latest dates at which the last killing frost in the spring and the first killing frost in the fall have occurred at 16 field stations in the Great Plains area. The data for this diagram were obtained as follows: For Havre, Dickinson, Mandan (Bismarck), Redfield, Hays, Woodward, Lawton, Chillicothe (from Quanah), Amarillo, Dalhart, and Big Spring, from United States Weather Bureau reports; for Moccasin, Newell, Ardmore, and Akron, from the Office of Biophysical Investigations, Bureau of Plant Industry; for Tucumcari, from United States Weather Bureau reports for 1905 to 1912 and from New Mexico Bulletin No. 130 for 1913 to 1921 (3).

very dark gray to black loam and the next 18 inches a slightly lighter colored clay loam with a highly granular structure; below this, for 8 inches, is a gray, cloddy, heavy silty clay changing into a highly calcareous gray clay.

At Chillicothe, Tex., the soil on the greater part of the present station consists of what the Bureau of Soils has defined as Foard clay loam, or at least it belongs to the Foard series. The texture is

[2] Soil descriptions were supplied by C. F. Marbut, in charge of Soil Investigations, Bureau of Soils.

apparently a clay loam. Judged from an exposure about 3 miles west of Chillicothe this soil is about as follows, from the surface downward: Loose, silty, structureless loam, 0 to 3 inches; 3 to 12 inches, very dark-brown granular clay loam; 12 to 30 inches, lighter colored, somewhat reddish brown clay loam less granular than the second layer; 30 inches and below, red clay, cloddy, without granulation, containing abundant lime carbonate.

At Amarillo, Tex., the greater part of the station, if not all, is covered by what was mapped as Amarillo clay loam. On the experimental area the soil is a little darker than typical Amarillo soil, approaching in its character the Richfield soils. The profile is as follows, from the surface downward: Dark brown, nearly black, rather heavy loam, 0 to 3 inches; dark reddish brown, rather cloddy clay loam with imperfect granulation, 3 to 8 inches; reddish brown clay without granulation, 8 to 30 inches; calcareous red clay without granulation, 30 inches. A whitish layer containing up to 30 per cent of accumulated carbonate of lime lies beneath the mature soils of the whole region at a depth ranging from 3 to 8 feet.

Woodward, Okla., is situated on the same group of soils as Chillicothe, but the field station is located on a very sandy tract of land about 1 mile south of town. A layer of sandy loam varying in thickness from 1 to 4 feet overlies the reddish clay subsoil. The clay soils outside of this sandy area possibly belong to the Foard series.

The soil type at Lawton, Okla., has not yet been definitely identified. The station is situated exactly on the boundary between the prairies and the Great Plains. The soil on the west end of the tract resembles the Kirkland soils of Payne county, Okla., while those on the eastern part correspond roughly to the Vernon soils of Texas. The profile on the eastern half of the station is as follows, from the surface downward: Dark-brown fine sandy loam without well-defined structure, 0 to 6 inches; dark-brown fine sandy loam with a tendency to granulation, 6 to 10 inches; a well-defined, dark red-brown heavy clay horizon, hard and tough when dry, 10 to 14 inches; red-brown clay loam with scattered lime concretions, 14 to 28 inches; red-brown clay loam without noticeable lime accumulation, 28 inches and below.

The soil at Dalhart, Tex., has not been studied, but a sample taken near the station indicated the following profile: The surface 2 inches, a loose grayish deflocculated sandy loam; next, down to a 12-inch depth, rather compact dark reddish brown loam or clay loam with columnar breakage on outcrops and no granulation; below this a calcareous loam. The soil may belong to the Miles series, but is probably less productive than that at Big Spring.

The soil at Big Spring, Tex., has not been definitely identified, but seems to resemble more closely the soils of the Miles series than those of any other group. It lies toward the eastern boundary of the section in which the Miles soils occur, has been developed under a higher rainfall, and is therefore a better soil than the average of this series. From the surface downward the soil profile is as follows: Dark reddish brown fine sandy loam with a slight tendency toward granulation, 0 to 6 inches; reddish brown clay loam with some fine sand, but cloddy and without granulation, 6 to 24 inches; below the 24-inch depth a reddish calcareous clay.

The soil at Tucumcari, N. Mex., has not been studied by any one connected with the United States Bureau of Soils. It is a loose reddish brown sandy loam, probably belonging to the Miles series or a soil type not yet defined, but poorer than the Miles. The soil at the station is friable and easily worked, but blows readily after the humus left by the native vegetation has been destroyed through cultivation.

NATIVE VEGETATION.[3]

Native vegetation furnishes a good index to climatic conditions and in a somewhat lesser degree to the soils of a section. Although generally classed as a short-grass section, there are decided variations in the native vegetation of the southern Great Plains, as pointed out in the following discussion.

The Hays, Kans., station is located in what may very properly be called the "wire-grass phase" of a short-grass community. Blue grama (*Bouteloua gracilis*) and buffalo grass (*Bulbilis dactyloides*) furnish the soil cover and are the predominating grasses, but scattered rather thickly in this short-grass sod are bunches of wire-grass (*Aristida longiseta*).

Chillicothe is in a transition zone where the prairie and the plains types of vegetation intermingle. The prevailing soil cover is buffalo grass with frequent mesquite bushes (*Prosopis juliflora*) scattered through it. In the rough places along watercourses and in sandy lands, prairie grasses, such as big bluestem (*Andropogon furcatus*) and little bluestem (*A. scoparius*) are found.

At the Amarillo, Tex., station is an almost pure short-grass association, consisting very largely of blue grama and buffalo grass.

As stated in the discussion of soils, the field station at Woodward, Okla., is on a sandy tract of limited extent on which the vegetation may perhaps be described as a shinnery community. The outstanding feature of this association is the scrub oak (*Quercus havardii*). With this oak are the big and little bluestems and sand sage (*Artemisia filifolia*).

Lawton, Okla., like Chillicothe, Tex., is in the transition zone between the prairies and plains. The native vegetation would perhaps be classified as a bunch-grass community, although it is made up of both bunch and short grasses. The big and little bluestems are associated here with buffalo grass and side-oats grama (*Bouteloua curtipendula*).

At Dalhart, Tex., the native vegetation is very much like that at Hays, Kans. The prevailing grasses are buffalo grass, blue and side-oats gramas, and wire-grass. In this fairly thick grass cover are scattered plants of *Psoralea tenuiflora* and *Ipomoea leptophylla*. Were the soil not rather sandy Dalhart, like Amarillo, would have a pure short-grass vegetation.

The vegetation at Big Spring, Tex., is much like that at Chillicothe, but has somewhat more of the desert characteristics. Buffalo grass is associated with the mesquite bush and several species of Aristida.

At Tucumcari, N. Mex., the native vegetation is difficult to classify because Tucumcari is on the dividing line between the desert and

[3] The writers are indebted to H. L. Shantz, Physiologist in charge of the Office of Plant Physiological and Fermentation Investigations of the Bureau of Plant Industry, for the facts on which the following brief outline of native vegetation is based.

plains flora. The mesquite bush and soapweed (*Yucca glauca*) are rather abundant, while the grass covering is thin. The principal grasses are blue grama, hairy grama (*Bouteloua hirsuta*), and galleta grass (*Hilaria jamesii*).

SORGHUM GROUPS AND VARIETIES.

No detailed classification of the sorghums will be attempted in this bulletin. The main groups and general relationships of the varieties are, however, indicated in Figure 5.

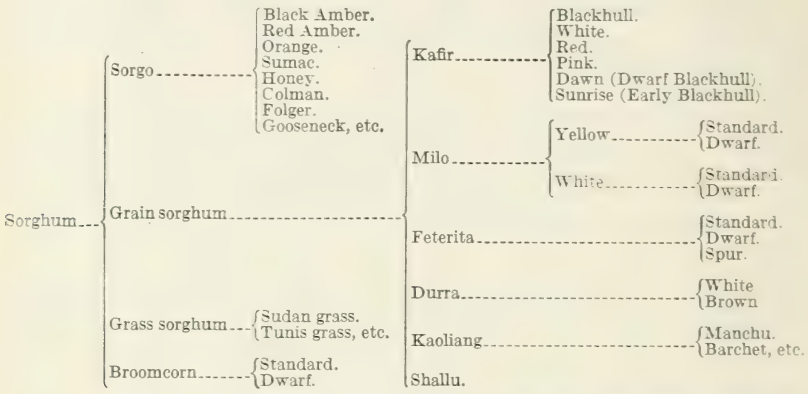

FIG. 5.—Diagram showing the main groups and general relationship of the varieties of sorghum.

Owing to the fact that sorghum varieties frequently cross-pollinate in the field, new varieties are constantly arising. Such varieties, being more or less intermediate in character between the parent varieties or groups, are difficult to classify. Such supposed hybrids or perhaps, in some cases, mutations are represented by the Darso, Schrock, and Freed sorghums. Dwarf hegari, although it came direct from Africa in almost its present form, is intermediate in general character between feterita and kafir and shows evidence of hybridization.

Only the most important of the many varieties of sorghum are listed in the diagram (fig. 5). In fact although the groups include practically all varieties that are grown commercially in the United States, they make up but a very small part of the numerous forms known to exist in Africa and Asia, the two continents where sorghums have been grown from the earliest times. When these numerous forms are brought together for comparison the dividing lines between the different groups are found to be very indefinite. Forms with white seeds and compact panicles, but having in addition rather sweet and juicy stems, seem to belong to the kafir as well as to the sorgo group. So, also, the kafirs grade imperceptibly into the durras and the durras into the milos and kaoliangs, and forms of the grass sorghums are found growing wild in Africa that are nearly as large and coarse as the cultivated sorghums. For present purposes, however, the simple classification just presented is sufficient. Only the two groups, sorgos and grain sorghums, are covered by the experiments discussed in this bulletin. The grass sorghums are discussed in Bulletin 981 (*12*) of the United States Department of Agriculture and the broomcorns in Farmers' Bulletins 768 (*8*) and 958 (*9*).

All of the sorghums are utilized to some extent for forage. Even broomcorn is sometimes pastured, or the stalks are harvested and fed to livestock after the brush has been removed. The grain sorghums are important as producers of fodder and stover as well as grain. The sorgos, or sweet sorghums, are grown primarily for hay and fodder, although a small part of the acreage is used in the manufacture of table sirup. Grass sorghums are grown almost exclusively for hay and pasture.

EXPERIMENTAL METHODS.

The methods of experimentation employed with different crops necessarily vary according to the nature of the crop. There are, however, certain recognized safeguards against errors, such as plat replication, which are common to all properly conducted field experiments. The methods followed in these sorghum experiments are briefly outlined below.

PRESERVATION OF SOIL UNIFORMITY.

At Hays, Kans., the sorghums on the experimental plats have usually alternated with small grains. At Chillicothe, Tex., since 1915 the sorghum plats have been included in a 4-year rotation of sorghum, cotton, annual legumes, and small grains. At the other stations the procedure has not been uniform from year to year. Usually the sorghums have followed small grains or cowpeas, although in some cases they were grown on summer fallow or following sorghum.

PLAT TECHNIQUE.

At Hays, Kans., Amarillo, Tex., and Woodward, Okla., the tests were usually conducted on duplicate twentieth-acre plats. This plan was followed also at Chillicothe, Tex., from 1913 to 1917, since which time smaller plats in triplicate have been used. At the other stations single tenth-acre plats were most common.

At all the stations the plats are seeded without dividing alleys, except the roadways between the plat series. Along these roads two guard rows are grown to prevent marginal influence, which is very noticeable in dry years. Within the plat series the influence of the adjoining plat is obviated by making the plat two rows wider than necessary and discarding one row from each side at harvest time.

In seeding the plats they are made somewhat longer than necessary and trimmed to the required length. At Chillicothe, Tex., it has been found better to defer trimming the plats until the sorghums are practically mature, for if the trimming is done when the plants are small there remains an opportunity for the plants at the ends of the plat to benefit by additional moisture late in the season.

SEEDING METHODS.

With certain exceptions, the data for comparison of varieties and rates of seeding (row space per plant) were taken from plats seeded at the most favorable dates, as determined by the date-of-seeding experiments and by experience. At Chillicothe, Tex., the three plats are seeded at different dates—one early, one medium, and one late—and the three yields are averaged. The relation between yields of different varieties varies with the date of seeding, and reliable comparison is possible only when each variety is sown on its most favorable date.

In most cases the sorghums were surface-planted on plowed ground with an ordinary 2-row corn planter in rows 33 to 44 inches apart. At Hays, Chillicothe, and Amarillo, large irregularities have been avoided by thick seeding and by thinning the plants to the desired stand. The close-drilled plats were ordinarily seeded with a grain drill.

HARVESTING METHODS.

The row plats are harvested with a corn binder by first cutting out the guard rows along the roadways and sides of the individual plats. It is not wise to delay harvesting until every plant has become fully mature, because the plants that ripen earliest will by that time have lost leaves and in some varieties much of their seed either through shattering or the attacks of birds. When the immature heads remain on the stalk there is usually sufficient sap left to complete the maturity of the seed.

In forage-crop experiments it has been found that accurate yields of both fodder and seed may be obtained from the same plat if this plat is harvested when 90 per cent of the plants are mature. The fodder weights are practically the same whether the sorghum is harvested at this time or at a somewhat earlier stage of maturity. The practice, therefore, has been to harvest at this stage and record the air-dry weight of the entire crop as the fodder yield. Later the heads are cut from the stalks and threshed to obtain the yield of seed.

METHODS OF OBTAINING DATA.

The row space per plant and stalk is obtained by an actual count of the plants and also the stalks on the plat or in every alternate row of the plat.

The length of the growing season is calculated as the time elapsing from the date the sorghum was seeded until 90 per cent of the plants had ripened seed.

The average height of the sorghum is determined at maturity by selecting several plants of average height by an ocular survey of the plat and then measuring these plants. The original method used was to measure 10 plants at different positions in the plat and take the average height. It was found, however, that the result was likely to be in error when this method was used, because while the operator is moving about within the plat he can not observe whether he is measuring undersized, average, or oversized plants in greater number.

At Hays, Kans., Chillicothe, Tex., and Amarillo, Tex., the experiments were conducted by a member of the staff of the Office of Forage-Crop Investigations, and all forage weights were reduced to an air-dry basis. The field weights were corrected for moisture content by the sample method described in Bulletin 353 of the United States Department of Agriculture (*13*).[4]

[4] The need of correcting field weights by the sample method is especially acute in experiments with sorghums, because varieties with large juicy stems cure so much more slowly than those with small pithy stalks. Several months of favorable curing weather are not sufficient to reduce all kinds of sorghum fodder to a uniform moisture content when it is standing in shocks. The relatively high yields of field-cured forage credited to late-maturing varieties of sorghums in comparison with early-maturing sorts are often due to their higher percentage of moisture. It is impossible to avoid such inequalities, except by reducing the moisture content in all varieties to a uniform percentage by means of samples. Short-season varieties harvested in the latter part of August or early in September may stand in shock for three months, the first half of which is usually very warm and dry. Late varieties, on the other hand, are usually not harvested until the last of September or middle of October; often not until the first frost. Their curing period, besides being much shorter, is marked by lower temperatures and often greater humidity. Obviously these large, coarse-stemmed late sorghums can not be expected to reach the same degree of dryness as the smaller, finer-stemmed early varieties.

The forage yields of different varieties are made comparable by taking 7-pound or 8-pound representative samples at the time the field weights are secured and drying these samples under an open shed. It has been found advisable to split the sorghum stalks longitudinally or, better still, to run them through a small silage cutter, so that the sample will dry out uniformly and quickly. The field weights are then reduced according to the percentage of moisture lost by the sample. This method makes it practicable to take the field weights at any time the plat is cut. The forage yields for Woodward, Lawton, Dalhart, Big Spring, and Tucumcari are of field-cured material, the weights usually being taken at threshing time.

The yields of seed have been obtained in most cases, because the forage value, especially of the grain sorghums, is enhanced by a high yield of seed. These yields are given both in pounds and bushels, for the reason that many investigators prefer the yield stated in pounds, while to the general reader comparisons are more easily made when the seed yields are given in bushels. In order that the bushel yields may be comparable, all are given on the basis of 56 pounds to the bushel regardless of whether the variety is a sorgo or a grain sorghum.

VARIETAL EXPERIMENTS.

Data are presented only on those features of the experiments which are known to affect directly the yields of fodder and seed, and are arranged by stations, so that a comparison is readily made of any given variety with other varieties adapted to that locality.

In very few instances has the same serial number (the same strain) been used for a variety throughout all the years. The practice has been to include in the test of a variety the most productive strain obtainable. This has resulted in many substitutions, because field selection of improved strains was in progress with practically all the varieties throughout the entire period covered by the experiments.

Many of the varieties are of only local importance; for example, at Hays, Kans., the Black Dwarf, Cole's Evergreen, Husser, Sudan corn, Early Buff durra, etc., were tested. Such varieties have been included in order that a statement of their performance and relationship to other varieties may be placed on record. This practice has been followed also at Chillicothe and Amarillo, Tex.

HAYS, KANS.[5]

The forage-crop experiments are conducted at the Fort Hays Experiment Station, 1 mile south of Hays, Kans., under a cooperative agreement with the Kansas Agricultural Experiment Station. The work was begun in 1913, but sorghums were practically a failure that year and the experiments were not fully outlined, so the results presented here cover only the period from 1914 to 1921. Reference to the climatic data in Table 1 shows that the average rainfall for this period was slightly below normal. The distribution of this rainfall, however, in most of the eight years was rather favorable for sorghum, so that the yields are very nearly what might be expected at Hays during any period of equal length.

[5] R. E. Getty has been in direct charge of the experiments at Hays.

The altitude of the station is 2,050 feet, and the soil and climatic conditions are fairly representative of the northern part of the sorghum belt, particularly of north-central Kansas. The relatively short growing season has limited the varieties under test to early and midseason sorghums. Commercial strains of Sumac sorgo rarely mature seed at Hays, and Kansas Orange, which is so popular in the eastern part of the State, does not mature regularly.

Insect pests have occasionally been destructive at this station. Grasshoppers are usually troublesome but have been controlled by spreading one or more applications of poisoned bran mash. Chinch bugs were quite destructive at Hays in 1910, 1911, and 1913, but aside from injury to milo in 1917 have not been especially troublesome during the period covered by this bulletin. Various forms of green bug, or plant lice, are sometimes present, but have apparently done very little damage to the experimental plats.

Disease has not been a factor of any considerable importance at Hays, though the kernel smut (*Sphacelotheca sorghi* (Link) Clint.) and head smut (*Sorosporium reilianum* (Kuhn) McAlp.) have both been found on the sorghums. The former, however, has been controlled by treating the seed with formaldehyde, and the latter has been kept out of the plats rather effectively, although it was present in some of the large fields of Red Amber sorgo.

In Table 2 are given, by years, the length of the growing season, average height of the plants, and the acre yields of air-dry fodder and threshed seed for each of the sorghum varieties under test at Hays. The average row space per plant and per stalk is given also, in order that the yields and stooling habits of the different varieties may be appraised more intelligently.[6]

The data from Table 2 are summarized for the most important varieties. Only the 8-year averages are given, and the relative yields are shown by means of percentages of a check variety, Red Amber being used as the check for all sorgos and Dawn kafir as the check for all grain sorghums. The average growing season is given in the summary only when data are available for a reasonable percentage of the years during which the variety was under test. Where data on this point are missing in the original tables it usually means that the variety did not mature that year.

A summary of results with miscellaneous varieties not included in the summary of Table 2 is given in Table 3. The actual and relative yields are based on the average for the series of years during which each variety was under test. Red Amber was used as a check for the sorgos, feterita (S. P. I. No. 22329) for the milos and feteritas, and Dawn kafir for kafirs and similar grain sorghums.

Several of these varieties made yields equal or superior to the check variety, but it must be considered that the value of a sorghum is also affected by characters other than the yield. Three varieties in this group, however, seem promising: these are Early Sumac sorgo, Dwarf feterita, and Spur feterita.

[6] The practice of increasing the last numeral by one where the discarded fraction equaled or exceeded one-half has been uniformly followed throughout this bulletin.

TABLE 2.—*Agronomic data regarding sorghum varieties grown at Hays, Kans., for one or more seasons in the 8-year period from 1914 to 1921, inclusive.*

Variety.	Serial No.	Years grown.	Growing season (days).	Dimensions (inches).			Yields per acre.			
				Row space.		Height of plants.	Air-dry forage.		Threshed seed.	
				Plant.	Stalk.		Pounds.	Tons.	Pounds.	Bushels.
Sorgos:										
Dakota Amber	F. C. I. 1528	1915	100	5.2	------	102	7,933	3.97	2,257	40.3
	F. C. I. 1614	1916	82	6.1	4.3	48	3,530	1.77	1,040	18.6
		1917	------	9.6	7.9	50	2,080	1.04	570	10.2
		1918	79	7.5	3.2	63	3,480	1.74	1,065	19.0
		1919	83	7.6	6.2	65	4,850	2.43	1,876	33.5
		1920	92	8.4	5.4	75	7,520	3.76	2,640	47.1
Average		------	87	7.4	5.4	67	4,899	2.45	1,575	28.1
Black Amber	S. Dakota 341	1914	87	4.7	3.2	------	5,020	2.51	1,610	28.8
	F. C. I. 7038	1915	96	5.0	------	109	9,767	4.88	2,027	36.2
		1916	90	4.7	3.9	54	4,360	2.18	400	7.1
		1917	------	6.8	6.3	69	5,730	2.87	1,110	19.8
		1918	85	5.1	3.4	69	4,870	2.44	310	5.5
		1919	87	8.5	5.0	68	6,550	3.28	1,777	31.7
		1920	102	12.5	7.7	86	8,820	4.41	2,470	44.1
		1921	81	5.0	3.8	85	6,285	3.14	1,868	33.4
Average		------	90	6.5	4.8	77	6,425	3.21	1,447	25.8
Early (Black) Amber	F. C. I. 8572-2	1915	93	5.2	------	115	10,300	5.15	827	14.8
		1916	87	4.9	4.2	60	3,990	2.00	220	3.9
		1917	------	5.7	5.5	73	4,670	2.34	560	10.0
		1918	85	4.5	3.3	76	5,610	2.81	605	10.8
		1919	87	7.4	4.6	72	5,270	2.64	1,575	28.1
Average		------	88	5.5	4.4	79	5,968	2.99	757	13.5
Red Amber	S. P. I. 17548	1914	90	3.5	2.2	------	5,850	2.93	860	15.4
		1915	99	4.3	------	106	11,433	5.72	1,503	26.8
		1916	94	3.1	2.9	54	5,040	2.52	170	3.0
		1917	------	4.9	3.9	68	5,880	2.94	980	17.5
		1918	93	5.1	2.9	67	6,260	3.13	395	7.1
		1919	93	8.8	4.4	70	6,900	3.45	1,658	29.6
		1920	107	8.7	6.1	96	10,140	5.07	1,860	33.2
		1921	86	5.4	3.5	86	6,210	3.11	1,350	24.1
Average		------	95	5.5	3.7	78	7,214	3.61	1,097	19.6
Red Amber	F. C. I. 6585	1915	99	5.1	------	90	9,600	4.80	1,927	34.4
		1916	90	6.6	4.8	48	3,590	1.80	580	10.4
		1917	------	5.6	5.8	60	4,280	2.14	890	15.9
		1918	85	5.1	3.3	65	4,990	2.50	835	14.9
		1919	87	7.8	4.9	60	6,370	3.19	2,360	42.1
		1920	105	7.8	5.4	80	9,960	4.98	3,390	60.5
		1921	83	6.3	4.4	74	5,415	2.71	1,710	30.5
Average		------	92	6.3	4.8	68	6,315	3.16	1,670	29.8
Black Dwarf	F. C. I. 7085	1914	94	8.2	5.1	------	6,048	3.02	1,280	22.9
		1915	111	6.2	------	92	11,067	5.53	1,383	24.7
		1916	100	3.7	3.4	48	4,940	2.47	270	4.8
		1917	------	5.8	5.3	59	3,840	1.92	540	9.6
		1918	93	5.9	4.1	56	4,690	2.35	255	4.6
Average		------	100	6.0	4.5	64	6,117	3.06	746	13.3
Cole's Evergreen	F. C. I. 01979	1914	102	6.9	4.1	------	6,960	3.48	590	10.5
		1915	------	5.5	------	111	11,200	5.60	550	9.8
		1916	------	2.0	1.9	42	6,190	3.10	0	0
		1917	------	5.5	6.0	66	6,270	3.14	60	1.1
		1918	------	3.8	2.3	60	5,620	2.81	0	0
Average		------	------	4.7	3.6	70	7,248	3.63	240	4.3
Western Orange	F. C. I. 6976	1914	94	7.6	4.5	------	5,808	2.90	1,760	31.4
		1915	111	6.0	------	96	10,600	5.30	2,157	38.5
		1916	102	5.2	3.9	38	3,220	1.61	290	5.2
		1917	------	6.0	5.6	65	4,680	2.34	780	13.9
	F. C. I. 9073	1918	93	6.5	3.5	58	4,920	2.46	410	7.3
		1919	97	9.0	6.1	64	6,070	3.04	1,617	28.9
		1920	112	7.6	4.6	80	11,210	5.61	2,860	51.1
		1921	90	6.2	4.5	76	6,975	3.49	1,620	28.9
Average		------	100	6.8	4.7	68	6,685	3.34	1,437	25.7

TABLE 2.—*Agronomic data regarding sorghum varieties grown at Hays, Kans., for one or more seasons in the 8-year period from 1914 to 1921, inclusive*—Continued.

Variety	Serial No.	Years grown	Growing season (days)	Dimensions (inches).			Yields per acre.			
				Row space.		Height of plants.	Air-dry forage.		Threshed seed.	
				Plant.	Stalk.		Pounds.	Tons.	Pounds.	Bushels.
Sorgos—Continued.										
Kansas Orange	S. P. I. 17556	1914	102	5.6	3.7		7,650	3.83	218	3.9
		1915		6.0		109	9,933	4.97	377	6.7
	F. C. I. 02553	1916		3.0	2.8	54	5,880	2.94	0	0
		1917		5.9	6.1	77	7,710	3.86	60	1.1
		1918		4.7	3.1	68	5,210	2.61	0	0
	K. S. A. C. 472	1919	114	17.1	6.9	69	5,140	2.57	1,048	18.7
		1920		6.9	4.3	96	14,590	7.30	0	0
	F. C. I. 2129	1921	104	6.6	4.6	81	7,710	3.86	825	14.7
Average				7.0	4.5	78	7,978	3.99	316	5.6
Sourless	F. C. I. 9074	1919	114	8.3	3.8	69	6,400	3.20	1,055	18.8
		1920		6.7	4.7	96	14,440	7.22	0	0
		1921	104	5.0	3.7	84	7,155	3.58	1,020	18.2
Average			109	6.7	4.1	83	9,332	4.67	692	12.3
Colman	S. P. I. 34986	1915		5.4		109	11,200	5.60	450	8.0
		1916		3.3	2.4	46	4,900	2.45	0	0
		1917		5.9	4.7	66	5,860	2.93	30	.7
		1918	104	4.7	2.3	67	6,530	3.27	220	3.9
	F. C. I. 03418	1920		7.2	5.6	96	13,370	6.69	2,550	45.5
		1921	95	6.2	4.3	81	6,630	3.32	990	17.7
Average				5.5	3.9	78	8,082	4.04	707	12.6
Leoti Red	F. C. I. 03417	1920		12.2	7.0	83	9,830	4.92	2,190	39.1
		1921	94	5.6	4.1	82	7,140	3.57	1,568	28.0
Average				8.9	5.6	83	8,485	4.25	1,879	33.6
Red X	F. C. I. 1479	1915		6.1		108	10,900	5.45	173	3.1
		1916		1.8	1.6	40	5,410	2.71	0	0
		1917		9.7	8.3	72	5,600	2.80	0	0
Average				5.9	5.0	73	7,303	3.65	58	1.0
Collier	F. C. I. 1461	1915		7.6		115	11,533	5.77	240	4.3
		1916		5.7	4.3	54	5,200	2.60	0	0
		1917		6.7	5.5	69	5,560	2.78	0	0
		1918		5.5	3.6	60	4,890	2.45	0	0
Average				6.4	4.5	75	6,796	3.40	60	1.1
McLean	S. P. I. 34985	1915		4.7		109	10,900	5.45	357	6.4
		1916		3.1	2.5	46	5,790	2.90	0	0
		1917		7.4	5.5	72	5,140	2.57	60	1.1
		1918	104	5.9	3.5	66	5,570	2.79	280	5.0
Average				5.3	3.8	73	6,850	3.43	174	3.1
Dwarf Ashburn	K. S. A. C. 434	1918		5.3	3.4	40	3,410	1.71	0	0
	K. S. A. C. 487	1919	114	6.6	3.9	51	5,770	2.89	1,783	31.8
		1920		11.2	8.7	60	8,900	4.45	1,460	26.1
	F. C. I. 8911	1921	104	10.2	8.2	48	4,935	2.47	1,080	19.3
Average				8.3	6.1	50	5,754	2.88	1,081	19.3
Early Sumac	F. C. I. 02552	1916		2.3	2.1	42	6,250	3.13	0	0
		1917		9.2	8.2	72	6,280	3.14	50	.9
		1918	102	4.3	2.8	55	4,850	2.43	195	3.5
		1919	98	6.2	4.1	66	6,790	3.40	1,915	34.2
		1920	112	7.3	5.5	74	11,120	5.56	2,600	46.4
		1921	90	5.0	3.6	71	7,140	3.57	1,493	26.7
Average			101	5.7	4.4	63	7,072	3.54	1,042	18.6

TABLE 2.—*Agronomic data regarding sorghum varieties grown at Hays, Kans., for one or more seasons in the 8-year period from 1914 to 1921, inclusive*—Continued.

Variety.	Serial No.	Years grown.	Growing season (days).	Dimensions (inches).			Yields per acre.			
				Row space.		Height of plants.	Air-dry forage.		Threshed seed.	
				Plant.	Stalk.		Pounds.	Tons.	Pounds.	Bushels.
Sorgos—Continued.										
Sumac	F. C. I. 1446	1914		4.8	2.7		6,620	3.31	10	.2
	S. P. I. 35038	1915		5.4		96	10,867	5.43	47	.8
	K. S. A. C. 428	1918		4.6	3.1	55	6,010	3.01	0	0
	K. S. A. C. 483	1919	114	6.5	3.5	74	10,180	5.09	2,879	51.4
		1920		10.4	6.9	81	14,060	7.03	0	0
		1921	104	5.2	3.5	69	7,860	3.93	435	7.8
Average				6.2	3.9	75	9,266	4.63	562	10.0
Grain sorghums:										
Dwarf White kafir	C. I. 342	1914	102	11.5	9.7		4,980	2.49	1,260	22.5
		1915	111	7.3		72	6,000	3.00	1,587	28.3
		1917		8.7	7.2	50	5,240	2.62	20	.4
		1918		6.2	3.8	42	3,900	1.95	105	1.9
		1919	112	21.6	16.7	44	2,440	1.22	938	16.8
Average			108	11.1	9.4	52	4,512	2.26	782	14.0
Dawn kafir	C. I. 340	1914	102	9.3	7.1		6,330	3.17	1,715	30.6
		1915	115	7.0		72	6,833	3.42	1,383	24.7
		1916		10.3	9.0	38	2,070	1.04	150	2.7
		1917		12.5	9.9	44	5,800	2.90	70	1.3
		1918		6.0	3.4	36	3,560	1.78	260	4.6
		1919	101	8.7	6.0	46	5,140	2.57	1,909	34.1
		1920	114	6.3	6.0	61	10,090	5.05	3,020	53.9
		1921	94	5.3	4.0	54	5,655	2.83	1,883	33.6
Average			105	8.2	6.5	50	5,685	2.85	1,299	23.2
Sunrise kafir	C. I. 472	1914	102	8.2	5.2		7,190	3.60	1,495	26.7
		1915		4.1		78	8,080	4.04	0	0
		1916		6.9	6.6	48	2,700	1.35	0	0
		1917		23.1	14.3	69	3,890	1.95	35	.6
		1918		8.4	4.5	53	4,980	2.49	380	6.8
		1919	107	13.2	8.3	60	4,350	2.18	1,350	24.1
		1920	117	5.9	5.8	82	10,350	5.18	2,610	46.6
		1921	97	5.5	4.3	75	6,840	3.42	1,808	32.3
Average			106	9.4	7.0	66	6,048	3.03	960	17.1
Dwarf Blackhull kafir	C. I. 330	1914	90		7.4		4,150	2.08	955	17.1
		1915	115	5.8		80	7,833	3.92	1,240	22.1
		1916		5.3	5.8	38	2,380	1.19	110	2.0
		1917		18.0	14.3	48	3,720	1.86	60	1.1
		1918		6.7	3.8	36	2,850	1.43	50	.9
Average				9.0	7.8	51	4,187	2.10	483	8.6
Blackhull kafir	S. P. I. 17569	1914	102	3.5	2.9		7,100	3.55	503	9.0
		1915		6.2		80	8,300	4.15	690	12.3
	F. C. I. 5894	1916		6.0	7.0	40	2,750	1.38	0	0
		1917		15.1	9.7	52	6,020	3.01	0	0
		1918		8.0	4.2	41	3,440	1.72	243	4.3
	C. I. 204	1919	109	9.1	6.3	48	4,240	2.12	1,177	21.0
	K. S. A. C. 539	1920		14.0	13.3	66	7,190	3.60	1,010	18.0
	K. S. A. C. 608	1921	108	13.5	11.4	57	6,450	3.23	1,965	35.1
Average				9.4	7.8	55	5,686	2.85	699	12.5
White kafir	S. P. I. 19695	1914	105	7.6	5.1		5,160	2.58	548	9.8
		1915		5.5		60	7,220	3.61	0	0
		1916		7.3	7.2	40	3,580	1.79	0	0
		1917		13.2	10.9	54	5,250	2.63	0	0
		1918		8.0	4.7	45	3,950	1.98	50	.9
Average				8.3	7.0	50	5,032	2.52	120	2.1

TABLE 2.—*Agronomic data regarding sorghum varieties grown at Hays, Kans., for one or more seasons in the 8-year period from 1914 to 1921, inclusive*—Continued.

Variety	Serial No.	Years grown	Growing season (days)	Dimensions (inches).			Yields per acre.			
				Row space.		Height of plants.	Air-dry forage.		Threshed seed.	
				Plant.	Stalk.		Pounds.	Tons.	Pounds.	Bushels.
Grain sorghums—Contd.										
Pink kafir	S. P. I. 19742	1914	109	7.1	4.9		7,220	3.61	495	8.8
		1915		6.1		65	8,430	4.22	0	0
	F. C. I. 5895	1916		6.4	6.0	40	3,060	1.53	0	0
		1917		10.9	8.1	54	6,260	3.13	0	0
		1918		10.9	5.1	43	4,180	2.09	0	0
		1920		7.4	5.9	79	10,870	5.44	0	0
Average				8.1	6.0	56	6,670	3.34	83	1.5
Pink kafir	C. I. 432	1915	115	5.0		72	10,860	5.43	2,640	47.1
		1916		4.7	5.3	36	3,060	1.53	0	0
		1917		8.4	7.4	49	5,480	2.74	0	0
		1918		5.0	2.7	39	3,830	1.92	30	.5
		1919	109	24.9	21.0	56	3,080	1.54	1,351	24.1
		1920	117	10.4	9.1	71	8,740	4.37	3,125	55.8
		1921	101	6.1	5.3	65	6,585	3.29	2,438	43.5
Average			111	9.2	8.5	55	5,948	2.97	1,369	24.4
Red kafir	S. P. I. 19492	1914	109	7.6	5.9		5,850	2.93	415	7.4
		1915		5.1		57	8,030	4.02	0	0
	F. C. I. 5896	1916		5.9	6.8	36	2,410	1.21	0	0
		1917		14.2	10.7	51	5,200	2.60	0	0
		1918		6.7	5.0	44	4,080	2.04	315	5.6
	F. C. I. 02820	1919	105	8.6	6.9	56	4,050	2.03	1,545	27.6
		1920		8.7	6.1	73	8,430	4.22	2,765	49.4
		1921	101	5.6	5.1	65	6,090	3.05	2,415	43.1
Average				7.8	6.6	55	5,518	2.76	932	16.6
Early White milo	F. C. I. 5886	1914	90	7.6	4.3		5,010	2.51	1,785	31.9
		1915	99	4.8		84	8,667	4.33	2,357	42.1
		1916	87	5.1	4.1	36	2,520	1.26	280	5.0
		1917		10.8	13.2	40	510	.26	110	2.0
		1918	85	6.4	4.2	59	4,020	2.01	1,000	17.9
		1919	91	17.8	8.3	60	4,790	2.40	2,070	37.0
		1920	96	9.6	6.8	63	7,970	3.99	2,750	49.1
		1921	79	6.4	4.7	70	4,770	2.39	1,515	27.1
Average			90	8.6	6.5	59	4,782	2.39	1,483	26.5
Dwarf White milo	F. C. I. 5899	1917		15.1	23.7	37	1,220	.61	220	3.9
		1918	98	5.7	2.7	41	4,190	2.10	70	1.3
		1919	109	16.9	8.2	46	5,070	2.54	2,138	38.2
	F. C. I. 8927	1920	111	7.7	6.1	53	8,390	4.20	2,565	45.8
		1921	93	6.4	4.9	48	5,490	2.75	2,258	40.3
Average			103	10.4	9.1	45	4,872	2.44	1,450	25.9
Dwarf Yellow milo	S. P. I. 18684	1914	102	7.7	3.8		4,880	2.44	793	14.2
		1915	112	4.7		70	9,767	4.88	2,293	40.9
		1916	118	4.6	4.5	30	2,630	1.32	110	2.0
		1917		37.7	19.2	38	1,310	.66	120	2.1
		1918	98	5.4	3.4	40	4,220	2.11	70	1.3
		1919	105	16.1	8.0	44	5,470	2.74	2,315	41.3
		1920	111	6.2	5.4	50	7,810	3.91	2,615	46.7
		1921	92	6.4	4.6	47	5,580	2.79	1,575	28.1
Average			105	11.1	7.0	46	5,208	2.61	1,236	22.1
Yellow milo	S. P. I. 35048	1914	102	13.6	6.5		4,900	2.45	775	13.8
		1915	115	8.0		88	6,800	3.40	780	13.9
	C. I. 234	1919	112	20.3	8.8	66	6,220	3.11	1,928	34.4
		1920	113	8.6	6.1	79	9,790	4.90	2,570	45.9
		1921	93	6.0	4.7	70	6,015	3.01	1,688	30.1
Average			107	11.3	6.5	76	6,745	3.37	1,548	27.6

TABLE 2.—*Agronomic data regarding sorghum varieties grown at Hays, Kans., for one or more seasons in the 8-year period from 1914 to 1921, inclusive*—Continued.

Variety.	Serial No.	Years grown.	Growing season (days).	Dimensions (inches).			Yields per acre.			
				Row space.		Height of plants.	Air-dry forage.		Threshed seed.	
				Plant.	Stalk.		Pounds.	Tons.	Pounds.	Bushels.
Grain sorghums—Contd.										
Feterita	F. C. I. 811	1915	104	6.3	------	80	6,933	3.47	1,330	23.8
		1916	92	5.5	3.6	32	2,330	1.17	380	6.8
		1917	------	14.6	11.5	47	2,870	1.44	410	7.3
		1918	85	5.1	3.1	62	4,350	2.18	640	11.4
		1919	90	13.9	8.1	64	4,340	2.17	1,944	34.7
Average			93	9.1	6.6	57	4,165	2.09	941	16.8
Feterita	S. P. I. 19517	1914	93	12.3	7.0	------	4,890	2.45	1,437	25.7
	S. P. I. 22329	1915	104	5.5	------	84	7,033	3.52	1,513	27.0
		1916	97	7.6	4.4	37	2,010	1.01	250	4.5
		1917	------	13.5	12.0	51	2,450	1.23	460	8.2
		1918	85	4.9	2.7	63	4,330	2.17	800	14.3
		1919	90	11.6	7.6	64	4,380	2.19	1,908	34.1
		1920	108	7.7	6.2	64	8,350	4.18	2,760	49.3
		1921	88	8.3	4.9	62	5,775	2.89	1,853	33.1
Average			95	8.9	6.4	61	4,902	2.46	1,373	24.5
Spur feterita	Texas 3232	1919	97	14.5	9.3	60	4,360	2.18	1,956	34.9
		1920	115	8.2	6.7	64	8,980	4.49	2,890	51.6
		1921	92	7.5	5.2	61	6,150	3.08	1,853	33.1
Average			101	10.1	7.1	62	6,497	3.25	2,233	39.9
Dwarf feterita	F. C. I 9076	1919	118	44.0	21.3	40	2,230	1.12	1,142	20.4
		1920	115	8.0	7.4	53	8,410	4.21	3,185	56.9
		1921	90	8.8	5.3	49	5,310	2.66	1,883	33.6
Average			108	20.3	11.3	47	5,317	2.66	2,070	37.0
Dwarf hegari	S. P. I. 34911	1914	102	8.6	4.6	------	6,280	3.14	625	11.2
		1915	104	7.3	------	66	7,067	3.53	2,277	40.7
		1916	------	4.3	3.6	40	3,790	1.90	0	0
		1918	------	18.4	6.5	45	4,310	2.16	272	4.9
	F. C. I. 9078	1919	107	15.7	7.5	47	4,880	2.44	1,555	27.8
		1920	114	7.8	5.5	59	9,880	4.94	3,440	61.4
		1921	84	5.7	3.9	53	6,360	3.18	1,800	32.1
Average			102	9.7	5.3	52	6,081	3.04	1,424	25.4
Freed sorghum	S. P. I. 29166	1914	87	9.2	3.4	------	4,670	2.34	1,423	25.4
	F. C. I. 9033	1915	99	5.0	------	96	7,000	3.50	1,650	29.5
		1916	82	3.9	4.0	48	2,290	1.15	430	7.7
		1917	------	9.2	8.4	50	1,720	.86	260	4.6
		1918	80	8.1	3.2	66	2,560	1.28	403	7.2
		1919	86	15.3	9.9	68	3,920	1.96	1,236	22.1
		1920	93	6.1	5.5	72	8,800	4.40	2,940	52.5
		1921	79	6.5	4.1	74	4,905	2.45	1,695	30.3
Average			87	7.9	5.5	68	4,483	2.24	1,255	22.4
Darso sorghum	K. S. A. C. 486	1919	108	14.8	11.0	48	4,100	2.05	1,805	32.2
		1920	------	12.3	9.9	53	6,990	3.50	1,180	21.1
		1921	103	5.7	5.3	46	5,730	2.87	1,170	20.9
Average			106	10.9	8.7	49	5,607	2.81	1,385	24.7
Schrock sorghum	F. C. I. 1481	1914	102	11.0	7.3	------	4,512	2.26	420	7.5
		1915	------	6.4	------	70	6,900	3.45	477	8.5
		1916	------	6.1	5.2	40	2,820	1.41	270	4.8
		1917	------	10.1	7.4	43	4,660	2.33	30	.5
		1918	------	8.6	4.5	41	3,960	1.98	190	3.4
		1919	117	20.3	12.8	44	4,710	2.36	1,937	34.6
		1920	------	6.4	4.9	69	10,830	5.42	2,060	36.8
		1921	103	5.8	5.0	46	6,315	3.16	1,350	24.1
Average			------	9.3	6.7	50	5,588	2.80	842	15.0

TABLE 2.—*Agronomic data regarding sorghum varieties grown at Hays, Kans., for one or more seasons in the 8-year period from 1914 to 1921, inclusive*—Continued.

Variety.	Serial No.	Years grown.	Growing season (days).	Dimensions (inches).			Yields per acre.			
				Row space.		Height of plants.	Air-dry forage.		Threshed seed.	
				Plant.	Stalk.		Pounds.	Tons.	Pounds.	Bushels.
Grain sorghums—Contd.										
Duallo	F. C. I. 8523	1914	93	11.3	6.2		4,160	2.08	1,505	26.9
		1915	104	6.6		86	9,033	4.52	1,843	32.9
		1916	108	5.5	4.8	40	2,110	1.06	320	5.7
Average			102	7.8	5.5	63	5,101	2.55	1,223	21.8
Husser	F. C. I. 03198	1920	115	5.8	5.2	79	9,130	4.57	2,430	43.4
		1921	95	5.8	4.2	63	5,910	2.96	855	15.3
Average			105	5.8	4.7	71	7,520	3.77	1,643	29.4
Husserita	F. C. I. 9085	1920	102	5.9	4.9	68	9,380	4.69	3,387	60.5
		1921	84	7.4	5.2	65	4,905	2.45	1,425	25.4
Average			93	6.7	5.1	67	7,143	3.57	2,406	43.0
Sudan corn	F. C. I. 03427	1920	106	6.8	5.7	86	9,560	4.78	1,880	33.6
		1921	95	6.1	4.2	73	6,105	3.05	458	8.2
Average			101	6.5	5.0	80	7,833	3.92	1,169	20.9
Early Buff durra	F. C. I. 02554	1917		11.9	11.3	49	1,490	.75	295	5.3
		1918	85	6.2	3.5	64	3,810	1.91	890	15.9
		1919	90	12.6	8.0	56	4,450	2.23	2,122	37.9
Average			88	10.2	7.6	56	3,250	1.63	1,102	19.7
Progressive kafir	F. C. I. 02249	1916		13.3	11.4	36	1,240	.62	30	.5
		1917		27.3	21.7	50	3,330	1.67	60	1.1
		1918		17.5	15.0	47	2,780	1.39	650	11.6
		1919	104	13.9	11.3	50	4,770	2.39	1,842	32.9
Average				18.0	14.9	46	3,030	1.52	646	11.5

SUMMARY FOR THE MORE IMPORTANT SORGHUM VARIETIES.

Variety.	Growing season.	Row space.		Height of plants.	Yields per acre.			
					Air-dry forage.		Threshed seed.	
		Plant.	Stalk.		Average.	Relative.	Average.	Relative.
Sorgos:	*Days.*	*Inches.*	*Inches.*	*Inches.*	*Tons.*	*Per ct.*	*Bush.*	*Per ct.*
Black Amber	90	6.5	4.8	77	3.21	89	25.8	132
Red Amber	95	5.5	3.7	78	3.61	100	19.6	100
Western Orange	100	6.8	4.7	68	3.34	93	25.7	131
Kansas Orange		7.0	4.5	79	3.99	111	5.6	29
Sumac [1]		6.1	4.3	70	4.26	118	7.6	39
Grain sorghums:								
Dawn kafir	105	8.2	6.5	50	2.85	100	23.2	100
Sunrise kafir	106	9.4	7.0	66	3.03	106	17.1	74
Blackhull kafir		9.4	7.8	55	2.85	100	12.5	54
Pink kafir [2]	110	9.0	8.0	55	3.05	107	22.5	97
Red kafir		7.8	6.6	55	2.76	97	16.6	72
Dwarf hegari [3]		9.7	5.3	52	3.04	107	25.4	109
Dwarf Yellow milo	105	11.1	7.0	46	2.61	92	22.1	95
Early White milo	90	8.6	6.5	59	2.39	84	26.5	114
Feterita	95	8.9	6.4	61	2.46	86	24.5	106
Schrock sorghum		9.3	6.7	50	2.80	98	15.0	65
Freed sorghum	87	7.9	5.5	68	2.24	79	22.4	97
Corn	97	15.6	13.5	61	1.98	69	14.1	61

[1] The results obtained with Early Sumac in 1916 and 1917 were used in computing these 8-year averages.
[2] Pink kafir C. I. No. 432 was not grown in 1914; hence the 8-year averages include the results for S. P. I. No. 19742 for that year.
[3] Dwarf hegari failed to germinate in 1917; hence there were no data for that year, and the averages are or seven years only.

TABLE 3.—*Average yields of forage and seed of the miscellaneous varieties of sorghum grown at Hays, Kans., during the 8-year period from 1914 to 1921, inclusive, each variety being compared with a check.*

Variety.	Serial No.	Years under test.	Variety used as check.	Forage yields.			Seed yields.		
				Tons per acre.		Relative; percentage of check.	Bushels per acre.		Relative; percentage of check.
				Variety.	Check.		Variety.	Check.	
Sorgos:									
Dakota Amber	F. C. I. 1614	1916–1920	Red Amber	2.45	3.42	72	28.1	18.1	155
Early (Black) Amber	F. C. I. 8572–2	1915–1919	do	2.99	3.55	84	13.5	16.8	80
Red Amber	F. C. I. 6585	1915–1921	do	3.16	3.71	85	29.8	20.2	148
Black Dwarf	F. C. I. 7085	1914–1918	do	3.06	3.45	89	13.3	14.0	95
Early Sumac	F. C. I. 02552	1916–1921	do	3.54	3.37	105	18.6	22.9	81
McLean	S. P. I. 34985	1915–1918	do	3.43	3.58	96	3.1	13.6	23
Colman	S. P. I. 34986	[1]1915–1921	do	4.04	3.75	108	12.6	18.6	68
Cole's Evergreen	F. C. I. 01979	1914–1918	do	3.63	3.45	105	4.3	14.0	31
Collier	F. C. I. 1461	1915–1918	do	3.40	3.58	95	1.1	13.6	8
Red X	F. C. I. 1479	1915–1917	do	3.65	3.73	98	1.0	15.8	6
Dwarf Ashburn	F. C. I. 8911	1918–1921	do	2.88	3.69	78	19.3	23.5	82
Sourless	F. C. I. 9074	1919–1921	do	4.67	3.88	120	12.3	29.0	42
Grain sorghums:									
Yellow milo	S. P. I. 35048 C. I. 234	1914–1915 1919–1921	Feterita 22329	3.37	3.05	110	27.6	33.8	82
Dwarf White milo.	F. C. I. 5899	1917–1921	do	2.44	2.53	96	25.9	27.8	93
Feterita	F. C. I. 811	1915–1919	do	2.09	2.02	103	16.8	17.6	95
Dwarf feterita	F. C. I. 9076	1919–1921	do	2.66	3.09	86	37.0	38.8	95
Spur feterita	Texas 3232	1919–1921	do	3.25	3.09	105	39.9	38.8	103
Early Buff durra	F. C. I. 02554	1917–1919	do	1.63	1.86	88	19.7	18.9	104
Darso sorghum	K. S. A. C. 486	1919–1921	Dawn kafir	2.81	3.48	81	24.7	40.5	61
Duallo sorghum	F. C. I. 8523	1914–1916	do	2.55	2.54	100	21.8	19.3	113
Progressive kafir	F. C. I. 02249	1916–1919	do	1.52	2.07	73	11.5	10.7	107
Dwarf Blackhull kafir	C. I. 330	1914–18	do	2.10	2.46	85	8.6	12.8	67

[1] Does not include 1919, because no data were available. The data for 1920 and 1921 were for F. C. I. No. 03418.

In the sorgo group the black-seeded Ambers, Western Orange, and Black Dwarf matured seed more often than other varieties, but were inferior in yield and sometimes in quality of forage to Red Amber (fig. 6), Early Sumac, and other later maturing sorgos. Leoti Red, a sorgo tested only from 1920 to 1922, now appears more promising than either Red Amber or Early Sumac, but more data are needed to determine its value definitely. Such varieties as McLean, Colman, Collier, and Red X matured too late in most seasons and were of secondary value to Kansas Orange and Sumac in the class of relatively late varieties. These late varieties have a limited value for fodder production in western Kansas, but in many years are unfit for silage because they do not have time to mature before they are harvested.

Of the grain sorghums about half a dozen standard varieties produced average yields of 22 to 26 bushels per acre. Among these varieties a choice may be made based on local needs and conditions. Pink kafir (C. I. No. 432) gave best results from the standpoint of combining high yield and quality of forage with satisfactory grain yield. (Fig. 7.) Sunrise kafir produced equally good forage but was deficient in grain yield. Dawn kafir produced forage of fair quality, but of much less value than the yields would indicate.

However, in unfavorable seasons this variety is more dependable than other kafirs as a grain crop. An early strain of Red kafir (F. C. I. No. 02820) has shown some promise as a general-purpose crop, and a new strain of Blackhull kafir (F. C. I. No. 9098) is also promising; but, in general, the standard strains of Red and Blackhull kafir have been too late in maturing and not drought resistant enough for the best results at Hays.

Milo, feterita, and Freed sorghum are all more productive than the kafirs in adverse seasons and should be considered if forage is secondary to the production of grain. Early White milo, the highest grain yielder, is unfortunately almost worthless as forage. Dwarf Yellow milo is probably the most satisfactory of the milo group, though certain strains of Dwarf White milo are almost as good. The standard milos are difficult to handle and are generally inferior in

FIG. 6.—Red Amber sorgo at Hays, Kans., in 1919. Seeded May 29. Photographed August 27.

grain yields. Chinch bugs have occasionally attacked the milos at Hays, notably in 1910, 1911, 1913, and 1917.

In the feterita group, common feterita has an excellent record for earliness and drought resistance. It is peculiarly adapted to late seeding or as insurance against entire failure. Spur feterita and a dwarf feterita (F. C. I. No. 9076) have yielded well, but have been tested only during favorable seasons. Being a few days later than common feterita they will probably not succeed so well under adverse conditions.

Dwarf hegari, considered for yield alone, appears more promising than its habits warrant. The unusually good grain yields in the wet years 1915 and 1920 resulted in a high average yield. Freed sorghum is very early and has proved a sure grain crop for late seeding or for use farther North and West. Schrock and Darso have proved unsat-

isfactory at Hays, Kans., both in yield and quality of grain. A number of other miscellaneous varieties, such as Progressive kafir, Duallo, and Early Buff durra, were tried for one or more years and discarded because of their lodging habit and various other objectionable qualities.

CHILLICOTHE, TEX.

The experiments at this point for 1913 and 1914 were located on a small tract of land adjoining the city of Chillicothe on the northwest. In 1915 the work was moved to a tract of 100 acres 4½ miles south and 1 mile west of Chillicothe. This land was purchased early in 1916 by the State of Texas and designated Texas Substation No. 12. From the beginning the forage-crop experiments have been conducted under a cooperative agreement with the Texas Agricultural Experiment Station.[7]

FIG. 7.—Pink kafir in the field tests at Hays, Kans., September 29, 1915.

Weather records have not been collected at Chillicothe for a very long time, but Table 1 shows that the rainfall was a little above normal during the 9-year period of these experiments. The distribution of the rainfall was unsuited to the sorghums, however, in at least three years—1913, 1917, and 1918.

The station is 1,406 feet above sea level, and the soil and climatic conditions are representative of a large area in north-central Texas. The most disadvantageous feature of the climate in growing sorghums is the dry period so often encountered in July and August. (See fig. 3

[7] From 1913 to 1917, inclusive, the experiments were in charge of R. W. Edwards, then connected with the Office of Forage-Crop Investigations. Since Mr. Edwards' resignation, February 25, 1918, the work has been directed by A. B. Cron. Work began at Chillicothe in 1905, and the results of the earlier years, 1905 to 1914, are presented in Bulletin 202 of the Texas Agricultural Experiment Station (6). Prior to 1913 the experiments were conducted under a plan different from that followed in the later years and are not included in this bulletin.

and Table 1.) At this comparatively low altitude and latitude (34° N.) practically all the sorghum varieties except the very latest mature regularly. Honey and Gooseneck sometimes fail to mature, but Sumac is well adapted to Chillicothe conditions.

Insect pests do very little damage at Chillicothe. On rare occasions the sorghum midge has caused some blighting of the late varieties; ordinarily, however, it does not appear at this station in sufficient numbers to cause appreciable damage. Chinch bugs are sometimes present in considerable numbers but the percentage of injury is small, even on susceptible varieties like milo. Green aphids are always present, but rarely attack the sorghum while the plants are small in sufficient numbers to retard the growth seriously. When the plants become large the presence of aphids does not seem to prevent normal growth.

Among the diseases which have to be guarded against, kernel smut is perhaps of first importance, but it has been easy to hold in check.

FIG. 8.—First crop of feterita at Chillicothe, Tex. Photographed July 20, 1914.

Head smut has never given trouble at Chillicothe, but the red-spot disease is prevalent every year and in humid seasons causes some injury to the foliage.

The length of growing season, average height of plants, and the acre yields of air-dry fodder and threshed seed are given by years in Table 4 for each of the sorghum varieties under test at Chillicothe. The average row spaces per plant and per stalk are also given.

In the experiments at Chillicothe, as in those at Hays, the practice has been to use the most productive strain of each variety as its representative in the tests. Many varieties not included in the experiments at Hays were grown at Chillicothe, because of the longer growing season at the latter point.

The stands obtained have, on the whole, been less uniformly good than at Hays. These stands are, however, better than will be found in the fields of farmers under like conditions. In any study of the

tabulated data it is well to refer to the climatic data in Table 1, since an explanation will be found there of many of the seeming inconsistencies in the yields, especially the seed yields. In 1914, for example, early varieties, such as feterita, Dwarf milo, and Freed, produced two crops of seed, the second harvest even larger that the first. (Figs. 8 and 9.) Later varieties, such as the kafirs, on the other hand, produced only one crop of heads and consequently smaller yields.

Table 4 also presents a summary of the results with the more important varieties under test. For the purpose of more exact comparisons of the different varieties, the relative yields are given as percentages of the yields of a check. Sumac was used as a check for the sorgos and Dwarf kafir for the grain sorghums.

FIG. 9.—Second crop of feterita at Chillicothe, Tex., grown from the stubble of the plants that produced the crop shown in Figure 8. Photographed October 15, 1914.

TABLE 4.—*Agronomic data regarding sorghum varieties grown at Chillicothe, Tex., for one or more seasons in the 9-year period from 1913 to 1921, inclusive.*

Variety.	Serial No.	Years grown.	Growing season (days).	Dimensions (inches).			Yields per acre.			
				Row space.		Height of plants.	Air-dry forage.		Threshed seed.	
				Plant.	Stalk.		Pounds.	Tons.	Pounds.	Bushels.
Sorgos:										
Dakota Amber	F. C. I. 6586	1914	89	4.0		62	6,850	3.43	1,500	26.8
		1915	81	7.6	4.6	59	4,650	2.33	1,470	26.3
		1916	83	6.7	5.3	57	2,150	1.08	790	14.1
		1917	85	6.0	3.5	46	2,060	1.03	260	4.6
		1918	98	8.2	4.9	50	1,888	.94	355	6.3
		1919	83	7.8	5.5	65	4,778	2.39	1,317	23.5
Average			87	6.7	4.8	57	3,729	1.87	949	16.9
Black Amber	S. P. I. 17695	1913	109	15.0		61	1,950	.98	125	2.2
		1914	92	4.7		66	9,100	4.55	570	10.2
	S. P. I. 36935	1916	83	6.3	5.4	62	2,445	1.22	920	16.4
Average			95	8.7		63	4,498	2.25	538	9.6

TABLE 4.—*Agronomic data regarding sorghum varieties grown at Chillicothe, Tex., for one or more seasons in the 9-year period from 1913 to 1921, inclusive*—Contd.

Variety	Serial No.	Years grown	Growing season (days)	Dimensions (inches). Row space. Plant.	Dimensions (inches). Row space. Stalk.	Dimensions (inches). Height of plants.	Yields per acre. Air-dry forage. Pounds.	Yields per acre. Air-dry forage. Tons.	Yields per acre. Threshed seed. Pounds.	Yields per acre. Threshed seed. Bushels.
Sorgos—Continued.										
Clubhead	F. C. I. 8708	1918	126	11.1	6.0	50	3,030	1.52	414	7.4
		1919	85	7.7	5.9	67	4,426	2.21	936	16.7
		1920	93	5.6	4.9	64	5,147	2.57	1,541	27.5
		1921	88	8.7	8.1	59	3,126	1.56	1,222	21.8
Average			98	8.3	6.2	60	3,932	1.97	1,028	18.4
Red Amber	S. P. I. 17548	1913	109	16.0		60	2,660	1.33	215	3.8
		1914	94	5.4		69	9,000	4.50	1,130	20.2
	F. C. I. 6585	1915	84	7.8	5.2	64	5,650	2.83	1,840	32.9
	S. P. I. 17548	1916	89	6.0	4.2	63	3,109	1.55	765	13.7
		1917	96	6.0	4.1	57	2,529	1.26	290	5.2
		1918	99	6.5	5.4	47	1,848	.92	185	3.3
		1919	84	7.2	5.7	69	4,778	2.39	1,251	22.3
		1920	91	5.7	4.9	65	4,833	2.42	1,548	27.6
		1921	88	8.7	7.1	72	3,340	1.67	1,219	21.8
Average			93	7.7	5.2	63	4,194	2.10	938	16.8
Whooper	F. C. I. 5873	1915	97	9.2	6.9	69	7,020	3.51	1,780	31.8
		1916	90	6.6	5.4	56	3,381	1.69	845	15.1
		1917	112	8.0	5.5	53	2,808	1.40	190	3.4
		1918	100	9.9	7.5	52	2,614	1.31	261	4.7
		1919	100	10.9	7.6	71	3,905	1.95	1,162	20.8
Average			100	8.9	6.6	60	3,946	1.97	848	15.2
Orange	S. P. I. 17556	1913	132	16.0		54	4,540	2.27	0	0
		1914	103	4.7		69	16,350	8.18	460	8.2
		1915	111	7.5	5.6	88	13,600	6.80	1,750	31.3
		1916	142	6.9	6.0	56	4,525	2.26	0	0
		1917	158	6.1	5.9	54	3,899	1.95	157	2.8
		1918	98	11.6	6.0	59	4,587	2.29	320	5.7
		1919	88	10.7	7.8	75	4,988	2.49	961	17.2
	C. I. 490	1920	93	5.7	5.1	65	5,104	2.55	1,440	25.7
		1921	87	8.7	8.7	66	3,700	1.85	1,100	19.6
Average			112	8.7	6.4	65	6,810	3.40	688	12.3
Planter	S. P. I. 17539	1913	132	18.0		43	2,480	1.24	0	0
		1916	142	6.0	3.6	55	3,977	1.99	0	0
Average			137	12.0	3.6	49	3,229	1.62	0	0
Collier	S. P. I. 21807	1914	94	4.6		63	10,000	5.00	640	11.4
		1915	92	8.8	5.8	79	8,000	4.00	1,500	26.8
		1916	90	6.0	4.8	59	2,681	1.34	490	8.8
		1917	100	6.3	4.6	60	2,667	1.33	242	4.3
		1918	98	8.7	4.5	50	4,436	2.22	231	4.1
Average			95	6.9	4.9	62	5,557	2.78	621	11.1
McLean	S. P. I. 34985	1915	105	7.2	5.4	90	5,000	2.50	1,190	21.3
		1916	118	6.7	5.2	60	2,742	1.37	0	0
		1917	121	6.0	4.9	58	3,198	1.60	136	2.4
		1918	98	7.8	5.7	54	4,924	2.46	30	.5
		1919	105	9.7	7.2	82	7,799	3.90	997	17.8
Average			109	7.5	5.7	69	4,733	2.37	471	8.4
White African	F. C. I. 1546	1915	113	12.9	10.6	90	10,600	5.30	1,270	22.7
		1916	142	6.3	4.9	61	4,692	2.35	0	0
		1917	158	6.0	5.0	60	4,658	2.33	64	1.1
		1918	99	9.5	6.3	51	5,776	2.89	61	1.1
		1919	107	12.5	8.1	78	8,032	4.02	1,360	24.3
		1920	121	6.0	5.0	85	12,003	6.00	1,738	31.0
		1921	112	8.7	7.9	82	9,482	4.74	1,338	23.9
Average			122	8.8	6.8	72	7,892	3.95	833	14.9

TABLE 4.—*Agronomic data regarding sorghum varieties grown at Chillicothe, Tex., for one or more seasons in the 9-year period from 1913 to 1921, inclusive*—Contd.

Variety.	Serial No.	Years grown.	Growing season (days).	Dimensions (inches).			Yields per acre.			
				Row space.		Height of plants.	Air-dry forage.		Threshed seed.	
				Plant.	Stalk.		Pounds.	Tons.	Pounds.	Bushels.
Sorgos—Continued.										
Dwarf Ashburn	S. P. I. 21936	1913	132	15.0		43	2,760	1.38	0	0
		1915	101	7.2	5.6	57	9,700	4.85	1,530	27.3
		1916	142	6.0	5.2	39	3,842	1.92	0	0
		1917	124	6.0	4.9	45	3,494	1.75	79	1.4
	F. C. I. 8911	1918	98	9.4	5.6	36	7,307	3.65	145	2.6
		1919	102	12.4	8.6	51	4,848	2.42	715	12.8
		1920	104	5.8	4.6	51	8,700	4.35	1,287	23.0
		1921	101	8.9	8.7	51	4,814	2.41	735	13.1
Average			113	8.8	6.2	47	5,683	2.84	561	10.0
Sumac	S. P. I. 17554	1913	132	19.0		43	2,560	1.28	0	0
	S. P. I. 35038	1914	162	4.2		80	14,450	7.23	1,760	31.4
		1915	117	7.2	4.6	77	13,700	6.85	1,190	21.3
	F. C. I. 1545	1916	142	6.1	4.3	52	4,575	2.29	0	0
		1917	158	6.1	6.0	64	5,005	2.50	82	1.5
		1918	98	8.0	5.9	49	5,828	2.91	228	4.1
	S. P. I. 35038	1919	101	10.8	7.5	65	6,105	3.05	1,045	18.7
		1920	103	6.0	4.9	67	9,116	4.56	1,220	21.8
		1921	101	8.7	8.4	59	5,072	2.54	1,046	18.7
Average			124	8.5	5.9	62	7,379	3.69	730	13.1
Honey	S. P. I. 29390	1913	132	16.0		25	1,570	.79	0	0
		1915	138	7.3	4.3	94	19,620	9.81	130	2.3
	S. P. I. 34925	1916	142	6.0	4.6	56	4,048	2.02	0	0
		1917	157	6.4	6.0	58	5,161	2.58	18	.3
	S. P. I. 29390	1918	98	8.6	4.0	50	7,426	3.71	43	.8
	F. C. I. 9576	1919	165	7.5	5.3		9,961	4.98	0	0
		1920	133	6.4	3.4	123	17,616	8.81	739	13.2
		1921	132	8.7	7.0	85	11,316	5.66	157	2.8
Average			137	8.4	4.9	70	9,590	4.8	136	2.4
Gooseneck	C. I. 43	1917	157	6.0	5.9	65	5,159	2.58	6	0.1
	Agrost. 2652	1920	134	5.7	3.9	111	10,581	5.29	860	15.4
		1921	133	8.7	7.0	94	13,116	6.56	382	6.8
Average			141	6.8	5.6	90	9,619	4.81	416	7.4
Grain sorghums:										
Dwarf white kafir	C. I. 342	1913				42	1,650	.83	0	0
		1914	91	7.8		45	9,050	4.53	1,110	19.8
		1915	99	8.6	7.1	42	5,210	2.61	1,550	27.7
		1916	94	7.1	6.1	41	2,575	1.29	500	8.9
Average			95	7.8	6.6	43	4,621	2.32	790	14.1
Dawn kafir	C. I. 340	1913		15.0		43	2,110	1.06	0	0
		1914	102	7.3		42	5,150	2.58	730	13.0
		1915	101	8.1	6.7	51	6,400	3.20	1,600	28.6
		1916	95	6.5	5.2	40	2,357	1.18	510	9.1
		1917	115	8.0	5.4	46	3,401	1.70	238	4.3
		1918	100	10.0	8.3	38	3,861	1.93	162	2.9
		1919	103	12.5	9.3	50	4,267	2.13	1,338	23.9
		1920	95	6.3	5.3	46	5,720	2.86	1,926	34.4
		1921	112			46	3,062	1.53	1,387	24.8
Average			103	9.2	6.7	45	4,036	2.02	877	15.7
Sunrise kafir	C. I. 472	1913				43	1,600	.80	0	0
		1914	102	7.5		60	6,250	3.13	960	17.1
		1915	101	6.9	5.5	71	8,280	4.14	1,800	32.1
		1916	95	6.1	5.1	51	2,904	1.45	605	10.8
		1917	115	8.0	4.7	57	3,855	1.93	248	4.4
		1918	100	9.0	6.8	46	4,871	2.44	182	3.3
		1919	103	11.1	7.7	69	5,687	2.84	1,339	23.9
		1920	115	8.0	6.3	50	4,980	2.49	1,624	29.0
		1921	111	9.6	9.2	51	4,138	2.07	1,525	27.2
Average			105	8.3	6.5	55	4,729	2.37	920	16.4

TABLE 4.—*Agronomic data regarding sorghum varieties grown at Chillicothe, Tex., for one or more seasons in the 9-year period from 1913 to 1921, inclusive*—Contd.

Variety	Serial No.	Years grown	Growing season (days)	Dimensions (inches). Row space. Plant.	Dimensions (inches). Row space. Stalk.	Height of plants.	Yields per acre. Air-dry forage. Pounds.	Yields per acre. Air-dry forage. Tons.	Yields per acre. Threshed seed. Pounds.	Yields per acre. Threshed seed. Bushels.
Grain sorghums—Contd.										
Dwarf Blackhull kafir	S. P. I. 17569	1913	133	14.0		33	1,900	.95	0	0
		1914	104	7.0		48	7,700	3.85	700	12.5
	F. C. I. 5894	1915	112	7.7	6.1	62	9,690	4.85	2,310	41.3
		1916	95	6.6	5.9	42	2,650	1.33	605	10.8
		1917	115	8.0	5.8	46	3,230	1.62	263	4.7
		1918	100	10.1	9.1	34	2,997	1.50	172	3.1
		1919	103	11.1	8.0	51	4,079	2.04	1,418	25.3
		1920	95	7.4	7.3	48	5,080	2.54	1,770	31.6
		1921	112	9.6	8.7	48	3,734	1.87	1,604	28.6
Average			108	9.1	7.3	46	4,562	2.28	982	17.5
White kafir	S. P. I. 19695	1913	133	15.0		34	1,920	.96	0	0
		1914	103	7.0		50	8,100	4.05	740	13.2
		1915	111	9.0	7.8	58	6,770	3.39	1,880	33.6
Average			116	10.3		47	5,597	2.80	873	15.6
Pink kafir	S. P. I 19742	1913	133	14.0		40	1,580	.79	0	0
		1914	112	8.1		48	8,350	4.18	750	13.4
	F. C. I. 5895	1915	112	8.0	6.4	63	8,480	4.24	2,580	46.1
		1916	118	6.1	5.6	42	1,953	.98	0	0
		1917	158	8.0	5.5	49	5,031	2.52	528	9.4
		1918	108	10.7	9.7	43	2,587	1.29	0	0
		1919	105	11.0	8.4	53	3,881	1.94	1,554	27.8
		1920	92	13.3	12.2	60	5,120	2.56	1,725	30.8
		1921	97	8.0	8.0	55	4,380	2.19	1,640	29.3
Average			115	9.7	8.0	50	4,596	2.30	975	17.4
Red kafir	S. P. I. 19492	1913	133	13.0		45	1,900	.95	0	0
		1914	112	7.0		43	11,200	5.60	840	15.0
	F. C. I. 5896	1915	111	8.1	5.9	62	8,190	4.10	2,170	38.8
		1916	118	6.1	5.2	42	2,120	1.06	0	0
		1917	158	8.0	6.4	44	3,563	1.78	332	5.9
		1918	108	11.4	10.3	34	2,647	1.32	53	0.9
	F. C. I. 9439	1919	106	11.2	8.2	56	4,959	2.48	1,784	31.9
		1920	112	7.5	6.5	57	7,773	3.89	2,482	44.3
		1921	115	9.6	9.2	55	3,598	1.80	1,484	26.5
Average			119	9.1	7.4	49	5,106	2.55	1,016	18.1
Early White milo	F. C. I. 5886	1913	109	16.0		44	2,210	1.11	980	17.5
		1914	91	6.9		60	6,100	3.05	1,190	21.3
		1915	85	9.5	6.8	58	4,750	2.38	1,820	32.5
		1916	81	6.6	5.5	52	2,498	1.25	955	17.1
		1917	94	8.0	5.6	45	2,050	1.03	282	5.0
		1918	101	10.1	8.5	47	2,766	1.38	599	10.7
		1919	86	10.4	8.0	59	3,653	1.83	1,330	23.8
		1920	89	5.3	4.5	59	5,160	2.58	1,596	28.5
		1921	91	13.8	9.6	61	4,156	2.08	1,882	33.6
Average			92	9.6	6.9	54	3,705	1.85	1,182	21.1
Dwarf White milo	F. C. I. 5899	1916	93	7.9	5.7	36	2,320	1.16	610	10.9
		1917	112	8.0	4.9	38	2,736	1.37	344	6.1
		1918	108	9.8	7.9	35	2,937	1.47	168	3.0
		1919	105	9.4	7.8	42	3,807	1.90	905	16.2
	F. C. I. 9079	1920	102	6.3	5.1	42	4,342	2.17	1,499	26.8
		1921	96	10.9	8.5	52	4,004	2.00	1,815	32.4
Average			103	8.7	6.7	41	3,358	1.68	890	15.9
Dwarf Yellow milo	S. P. I. 18684-2	1913	113	19.0		38	3,040	1.52	980	17.5
		1914	96	7.1		40	9,400	4.70	2,210	39.5
	S. P. I. 18684	1915	101	8.0	5.8	50	7,200	3.60	2,060	36.8
		1916	93	7.5	5.3	35	2,711	1.36	875	15.6
		1917	112	8.0	5.3	38	2,491	1.25	257	4.6
		1918	108	10.4	8.1	33	3,234	1.62	210	3.8
	S. P. I. 24968	1919	104	9.5	6.6	46	8,150	4.08	1,253	22.4
		1920	104	5.8	4.7	42	6,036	3.02	1,940	34.6
		1921	96	10.6	7.6	52	3,690	1.85	1,786	31.9
Average			103	9.5	6.2	42	5,106	2.56	1,286	23.0

TABLE 4.—*Agronomic data regarding sorghum varieties grown at Chillicothe, Tex., for one or more seasons in the 9-year period from 1913 to 1921, inclusive*—Contd.

Variety.	Serial No.	Years grown.	Growing season (days).	Dimensions (inches).			Yields per acre.			
				Row space.		Height of plants.	Air-dry forage.		Threshed seed.	
				Plant.	Stalk.		Pounds.	Tons.	Pounds.	Bushels.
Grain sorghums—Contd.										
Yellow milo	S. P. I. 24960	1917	112	8.1	5.3	52	2,740	1.37	326	5.8
		1918	108	10.8	8.5	45	3,479	1.74	238	4.3
Average			110	9.5	6.9	49	3,110	1.56	282	5.1
Feterita	F. C. I. 811	1913	111	27.0		48	1,930	.97	600	10.7
		1914	92	7.8		54	9,850	4.93	2,990	53.4
		1915	83	9.2	6.9	55	5,050	2.53	1,570	28.0
		1916	86	8.0	5.5	49	2,623	1.31	1,040	18.6
		1917	100	8.0	5.8	45	2,320	1.16	307	5.5
		1918	101	11.4	8.6	47	2,667	1.33	403	7.2
		1919	89	11.4	6.9	58	4,426	2.21	1,481	26.4
		1920	84	5.4	4.4	55	5,380	2.69	2,027	36.2
		1921	87	19.0	10.3	63	2,800	1.40	1,736	31.0
Average			93	11.9	6.9	53	4,116	2.06	1,350	24.1
Feterita	S. P. I. 19517	1913	110	21.0		55	2,080	1.04	600	10.7
	S. P. I. 22329	1914	96	7.7		57	12,050	6.03	2,880	51.4
		1915	84	8.3	6.6	57	4,950	2.48	1,530	27.3
		1916	86	6.7	5.1	51	2,750	1.38	1,020	18.2
		1917	100	8.0	6.0	46	2,200	1.10	231	4.1
		1918	101	11.8	8.7	42	2,139	1.07	139	2.5
		1919	89	10.4	6.6	60	4,215	2.11	1,427	25.5
		1920	90	6.4	5.3	55	4,840	2.42	1,932	34.5
		1921	89	10.8	7.7	59	3,860	1.93	1,674	29.9
Average			94	10.1	6.6	54	4,343	2.17	1,270	22.7
Spur feterita	Texas 3232	1919	100	11.3	8.0	59	5,480	2.74	1,622	29.0
		1920	101	6.7	5.9	54	5,815	2.91	1,643	29.3
		1921	96	13.3	11.4	63	3,464	1.73	1,795	32.1
Average			99	10.4	8.4	59	4,920	2.46	1,687	30.1
Dwarf hegari	S. P. I. 34911	1913	133	18.0		43	2,080	1.04	0	0
		1914	89	10.0		48	12,200	6.10	3,170	56.6
		1915	104	9.2	6.9	58	9,090	4.55	2,150	38.4
		1916	118	7.0	5.1	42	2,365	1.18	0	0
		1917	158	9.4	5.8	46	7,887	3.94	623	11.1
		1918	109	11.9	8.6	40	3,597	1.80	0	0
		1919	111	12.9	7.9	47	5,251	2.63	403	7.2
		1920	107	5.8	4.0	45	7,094	3.55	2,380	42.5
		1921	101	9.4	6.7	59	6,208	3.10	1,935	34.6
Average			114	10.4	6.4	48	6,197	3.10	1,185	21.2
Brown kaoliang	S. P. I. 38197	1915	89	7.3	5.4	64	5,100	2.55	2,260	40.4
		1916	83	6.0	5.4	59	2,406	1.20	880	15.7
		1917	95	8.0	5.6	54	2,420	1.21	347	6.2
		1918	100	12.4	11.6	58	1,419	.71	356	6.4
Average			92	8.4	7.0	59	2,836	1.42	961	17.2
White kaoliang	S. P. I. 38205	1916	93	7.2	6.3	64	2,688	1.34	655	11.7
		1918	108	11.9	10.6	61	2,132	1.07	68	1.2
		1919	97	16.1	12.5	79	3,724	1.86	1,314	23.5
		1920	100	12.5	11.2	76	4,552	2.28	1,503	26.8
		1921	91	9.4	8.9	79	3,362	1.68	1,529	27.3
Average			98	11.4	9.9	72	3,292	1.65	1,014	18.1
Freed sorghum	S. P. I. 29166	1913	100	16.0		55	1,340	.67	260	4.6
		1914	91	6.3		67	5,550	2.78	1,120	20.0
		1915	82	9.8	5.0	64	4,100	2.05	1,550	27.7
		1916	76	6.9	5.0	59	2,129	1.06	655	11.7
		1917	85	6.2	4.2	48	1,890	.95	320	5.7
		1918	99	10.1	5.4	55	2,772	1.39	363	6.5
		1919	83	12.4	5.9	66	3,583	1.79	1,125	20.1
		1920	88	7.3	4.6	65	5,216	2.61	1,303	23.3
		1921	91	9.4	5.1	66	2,496	1.25	1,383	24.7
Average			88	9.4	5.0	61	3,231	1.62	898	16.0

TABLE 4.—*Agronomic data regarding sorghum varieties grown at Chillicothe, Tex., for one or more seasons in the 9-year period from 1913 to 1921, inclusive*—Contd.

Variety.	Serial No.	Years grown.	Growing season (days).	Dimensions (inches).			Yields per acre.			
				Row space.		Height of plants.	Air-dry forage.		Threshed seed.	
				Plant.	Stalk.		Pounds.	Tons.	Pounds.	Bushels.
Grain sorghums—Contd.										
Darso sorghum	F. C. I. 1530	1916	93	6.3	5.3	39	2,529	1.26	615	11.0
		1917	112	8.0	5.5	41	2,496	1.25	409	7.3
		1918	106	10.0	9.1	39	1,835	.92	149	2.7
		1919	98	10.9	7.9	49	3,717	1.86	1,734	31.0
		1920	100	8.1	7.5	47	5,374	2.69	2,021	36.1
		1921	103	9.7	9.4	49	2,698	1.35	1,549	27.7
Average			102	8.8	7.5	44	3,108	1.56	1,080	19.3
Schrock sorghum	F. C. I. 1481	1915	99	7.4	5.8	58	7,750	3.88	2,580	46.1
		1916	102	6.2	5.5	39	2,761	1.38	490	8.8
		1917	117	8.0	4.6	45	3,619	1.81	304	5.4
		1918	108	11.2	8.8	37	2,970	1.49	66	1.2
Average			107	8.2	6.2	45	4,275	2.14	860	15.4

SUMMARY OF THE MORE IMPORTANT SORGHUM VARIETIES.

Variety.	Growing season.	Row space.		Height of plants.	Yields per acre.			
		Plant.	Stalk.		Air-dry forage.		Threshed seed	
					Average.	Relative.	Average.	Relative.
Sorgos:	*Days.*	*Inches.*	*Inches.*	*Inches.*	*Tons.*	*Per ct.*	*Bush.*	*Per ct*
Red Amber	93	7.7	5.2	63	2.10	57	16.8	128
Orange	112	8.7	6.4	65	3.40	92	12.3	94
Dwarf Ashburn	113	8.8	6.2	47	[1] 3.23	88	[1] 12.1	92
Sumac	124	8.5	5.9	62	3.69	100	13.1	100
Honey	137	8.4	4.9	70	[1] 5.45	148	[1] 2.9	22
Grain sorghums:								
Dawn kafir	103	9.2	6.7	45	2.02	89	15.7	90
Sunrise kafir	105	8.3	6.5	55	2.37	104	16.4	94
Dwarf kafir [2]	108	9.1	7.3	46	2.28	100	17.5	100
Pink kafir	115	9.7	8.0	50	2.30	101	17.4	99
Red kafir	119	9.1	7.4	49	2.55	112	18.1	103
Early White milo	92	9.6	6.9	54	1.85	81	21.1	121
Dwarf Yellow milo	103	9.5	6.2	42	2.56	112	23.0	131
Feterita (F. C. I. No. 811)	93	11.9	6.9	53	2.06	90	24.1	138
Feterita (S. P. I. No. 22329)	94	10.1	6.6	54	2.17	95	22.7	130
Freed sorghum	88	9.4	5.0	61	1.62	71	16.0	91
Dwarf hegari	114	10.4	6.4	48	3.10	136	21.2	121

[1] Yields for 1914 interpolated. (Eight-year average yield of X : 8-year average yield of Sumac sorgo : : 1914 yield of X : 1914 yield of Sumac sorgo.)

[2] Dwarf kafir was used as a check because it has been grown longest at Chillicothe. It is a dwarf selection from Blackhull kafir, S. P. I. No. 17569, and is well adapted to the conditions at Chillicothe.

Table 5 presents the yields of less important varieties of sorghum each of which is compared with a check variety having about the same length of growing season. In order to understand properly the percentage yields of forage given for the first four varieties in this table it is well to remember that Red Amber, the check, produces only 57 per cent as much forage as Sumac. Although the Whooper and Clubhead sorgos are credited with more forage than Red Amber, their yields are much less than that of Sumac, the standard sorgo variety of Texas and Oklahoma.

TABLE 5.—*Average yields of forage and seed of the miscellaneous varieties of sorghum grown at Chillicothe, Tex., during the 9-year period from 1913 to 1921, inclusive, each variety being compared with a check.*

Variety.	Serial No.	Years under test.	Variety used as a check.	Forage yields.			Seed yields.		
				Tons per acre.		Relative; percentage of check.	Bushels per acre.		Relative; percentage of check.
				Variety.	Check.		Variety.	Check.	
Sorgos:									
Dakota Amber	F.C.I. 6586	1914–1919	Red Amber	1.87	2.24	83	16.9	16.3	104
Black Amber	S.P.I. 17695 [1]	1913–1914–1916	do	2.25	2.46	91	9.6	12.6	76
Clubhead	F.C.I. 8708	1918–1921	do	1.97	1.85	106	18.4	18.8	98
Whooper	F.C.I. 5873	1915–1919	do	1.97	1.79	110	15.2	15.5	98
Planter	S.P.I. 17539	1913–1916	Sumac	1.62	1.79	91	0	0	------
Collier	S.P.I. 21807	1914–1918	do	2.78	4.36	64	11.1	11.7	95
McLean	S.P.I. 34985	1915–1919	do	2.37	3.52	67	8.4	9.1	92
White African	F.C.I. 1546	1915–1921	do	3.95	3.52	112	14.9	9.1	164
Gooseneck	Agros. 2652 [2]	1917–1920–1921	do	4.81	3.20	150	7.4	14.0	53
Grain sorghums:									
Dwarf White kafir	C.I. 342	1913–1916	Dwarf kafir	2.32	2.75	84	14.1	16.2	87
White kafir	S.P.I. 19695	1913–1915	do	2.80	3.22	87	15.6	17.9	87
Darso sorghum	F.C.I. 1530	1916–1921	do	1.56	1.82	86	19.3	17.4	111
Schrock sorghum	F.C.I. 1481	1915–1918	do	2.14	2.32	92	15.4	15.0	103
Spur feterita	Texas 3232	1919–1921	Feterita 811	2.46	2.10	117	30.1	31.2	96
Dwarf White milo	F.C.I. 5899 [3]	1916–1921	do	1.68	1.68	100	15.9	20.8	76
Brown kaoliang	S.P.I. 38197	1915–1918	do	1.42	1.58	90	17.2	14.8	116
White kaoliang	S.P.I. 38205	1916–1921	do	1.65	1.68	98	18.1	20.8	87

[1] S.P.I. No. 36935 in 1916. [2] C.I. No. 43 in 1917. [3] F.C.I No. 9079 in 1920 and 1921

It is apparent from Table 4 that Red Amber, a variety which occupies a leading position among the sorgos at Hays, Kans., ranks very low in yield of forage at Chillicothe. Sumac sorgo, on the other hand, made good yields of both fodder and seed. (See fig. 15.) The experiments show that it is entitled to the high regard in which it is held by farmers, and no other variety, with the possible exception of Honey, seems worthy of replacing it in their favor. (Fig. 10.) Honey makes a yield of forage nearly 50 per cent larger than that of Sumac, at Chillicothe but does not mature seed regularly. White African is another variety that made a good showing at Chillicothe. During the seven years it was grown, this variety produced 12 per cent more forage and 64 per cent more seed than Sumac.

Among the grain sorghums Dwarf Yellow milo and feterita have produced the highest average grain yields. The grain yield of feterita (F. C. I. No. 811) slightly exceeded that of Dwarf milo, but the latter variety made the most forage. Feterita is favored for late planting and as an insurance crop against complete failure from drought. The true value of Spur feterita has not yet been determined, but its leafiness and relatively high forage value combined with its good grain yield make it a promising crop. (Fig. 11.) It was 12 days later in maturing than ordinary feterita during the test period of 1919 to 1921 and therefore would not fit in so well as a drought-evading crop.

Red kafir has made better yields than either the Blackhull or the Pink variety. It is not grown so extensively as Blackhull, however, possibly because the market prefers a white-seeded kafir. Dwarf hegari, though it made good yields of both forage and seed, is not valued highly, because it is so variable in its habits of growth and in its reactions to climatic conditions.

AMARILLO, TEX.

Experiments at Amarillo were conducted at the cereal field station in cooperation with the Office of Cereal Investigations.[8] Weather records which are available for a period of 30 years show that Amarillo has an average annual rainfall of 20.99 inches, 15.68 inches of which comes during the growing season. (See fig. 3 and Table 1.) This seasonal rainfall is almost as large as that at Chillicothe and is better distributed. The average for the period while the sorghums were under test was somewhat below the normal. The seasons of 1913 and 1916 were unusually poor, while that of 1915 was exceptionally favorable from the standpoint of rainfall.

The altitude at Amarillo is 3,600 feet, which results in a rather short growing season. Sumac sorgo seldom matures good seed crops

FIG. 10.—Honey sorgo at Chillicothe, Tex., in 1920. Seeded May 28. Photographed September 17.

in this location, but it is one of the most popular forage varieties. The evaporation rate is very high at Amarillo, and in periods of low rainfall the crops suffer, because transpiration is rapid and the reserve moisture in the soil is quickly exhausted.

Insect pests have not been troublesome at Amarillo; chinch bugs are perhaps most likely to damage the sorghums. Kernel smut is the most prevalent disease, but that has been easily controlled.

In Table 6 are given the length of the growing season, average row space per plant and per stalk, height of plants, and the acre yields of air-dry fodder and threshed seed of the sorghum varieties under test at Amarillo.

Table 6 reveals the fact that a period of five years is not sufficiently long to provide data for a reliable estimate of the value of sorghum

[8] The tests at Amarillo were continued for only five years, 1913 to 1917, and were in charge of A. B. Cron.

varieties. The seed yields are especially unreliable. Many varieties matured seed in only three out of the five years and others in only two years. The results from a forage standpoint are much better, and the relation of the different varieties as to their forage value would perhaps not be greatly different if the test period were longer.

Thin stands were obtained in many cases; but the failure to obtain a good stand did not decrease yields to any extent except in 1915, when the rainfall was sufficient to support a thick stand.

FIG. 11.—A field of Spur feterita at Chillicothe, Tex., in 1920. Photographed August 23.

The summary of Table 6 presents the results with the more important varieties under test. Black Amber was used as a check for the sorgos and Dawn kafir for the grain sorghums.

TABLE 6.—*Agronomic data regarding sorghum varieties grown at Amarillo, Tex., for one or more seasons in the 5-year period from 1913 to 1917, inclusive.*

Variety.	Serial No.	Years grown.	Growing season (days).	Dimensions (inches).			Yields per acre.			
				Row space.		Height of plants.	Air-dry forage.		Threshed seed.	
				Plant.	Stalk.		Pounds.	Tons.	Pounds.	Bushels.
Sorgos:										
Dakota Amber	F. C. I. 6586	1914	83	3.8	2.2	59	4,419	2.21	1,278	22.8
		1915	108	12.6	4.8	72	7,860	3.93	3,000	53.6
	F. C. I. 1614	1916	71	13.9	7.9	39	849	.42	143	2.6
		1917	96	11.5	6.3	51	1,480	.74	360	6.4
Average			90	10.5	5.2	55	3,652	1.83	1,195	21.4
Black Amber	S. P. I. 32384	1913	86	14.6	6.0	52	1,700	.85	367	6.6
		1914	88	4.1	2.0	66	5,250	2.63	1,159	20.7
	F. C. I. 6589	1915	108	10.2	3.3	83	9,920	4.96	2,900	51.8
		1916	121	8.6	4.7	57	2,603	1.30	404	7.2
		1917	112	8.7	3.7	65	4,900	2.45	1,190	21.3
Average			103	9.2	3.9	65	4,875	2.44	1,204	21.5

TABLE 6.—*Agronomic data regarding sorghum varieties grown at Amarillo, Tex., for one or more seasons in the 5-year period from 1913 to 1917, inclusive*—Continued.

Variety	Serial No.	Years grown	Growing season (days)	Dimensions (inches)			Yields per acre.			
				Row space.		Height of plants.	Air-dry forage.		Threshed seed.	
				Plant.	Stalk.		Pounds.	Tons.	Pounds.	Bushels.
Sorgos—Continued										
Clubhead	F. C. I. 6581	1914	90	5.5	3.0	55	5,100	2.55	938	16.8
	F. C. I. 8708	1915	113	10.3	4.5	74	11,140	5.57	3,320	59.3
		1916	116	18.6	6.9	51	1,928	.96	275	4.9
		1917	126	14.6	6.9	63	4,300	2.15	710	12.7
Average			111	12.3	5.3	61	5,617	2.81	1,311	23.4
Red Amber	S. P. I. 17548	1913	87	9.2	4.6	36	2,367	1.18	206	3.7
		1914	90	2.5	1.4	61	5,750	2.88	463	8.3
	F. C. I. 6585	1915	100	9.1	4.2	77	10,154	5.08	2,932	52.4
	S. P. I. 17548	1916	126	9.5	3.7	49	3,569	1.78	0	0
		1917	126	9.5	5.4	61	4,631	2.32	770	13.8
Average			106	8.0	3.9	57	5,294	2.65	874	15.6
Whooper	F. C. I. 5873	1916	126	15.4	13.0	53	1,482	.74	0	0
		1917	145	24.3	10.1	61	2,640	1.32	570	10.2
Average			136	19.9	11.6	57	2,061	1.03	285	5.1
Orange	S. P. I. 17556	1913	120	12.5	6.9	45	2,465	1.23	0	0
		1914	------	1.9	1.6	58	8,125	4.06	0	0
	F. C. I. 8730	1915	121	7.6	4.3	86	12,640	6.32	2,110	37.7
		1916	126	4.3	4.0	40	3,452	1.73	0	0
		1917	145	4.6	3.8	72	7,640	3.82	305	5.4
Average			128	6.2	4.1	60	6,864	3.43	483	8.6
Collier	S. P. I. 21807	1914	93	3.3	1.7	60	6,025	3.01	715	12.8
		1915	108	17.6	4.9	79	9,900	4.95	2,450	43.8
Average			101	10.5	3.3	70	7,963	3.98	1,583	28.3
Colman	S. P. I. 34986	1913	121	8.4	4.0	54	6,000	3.00	0	0
		1914	------	2.5	1.7	62	6,450	3.23	139	2.5
Average			121	5.5	2.9	58	6,225	3.12	70	1.3
McLean	S. P. I. 34985	1913	121	9.8	5.4	54	3,633	1.82	316	5.6
		1914	113	2.7	2.0	67	7,100	3.55	206	3.7
		1915	123	10.2	5.8	102	12,920	6.46	1,720	30.7
		1916	126	11.1	5.8	61	3,410	1.71	0	0
		1917	135	9.2	5.6	79	6,520	3.26	515	9.2
Average			124	8.6	4.9	73	6,717	3.36	551	9.8
Kansas Straightneck	F. C. I. 02224	1915	133	17.4	5.7	102	13,840	6.92	2,080	37.1
		1916	126	13.5	6.4	47	3,772	1.89	0	0
		1917	145	11.4	5.9	80	7,960	3.98	0	0
Average			135	14.1	6.0	76	8,524	4.26	693	12.4
Johnson grass × sorgo	F. C. I. 5849	1915	118	6.8	3.7	72	10,740	5.37	2,850	50.9
		1916	126	8.5	4.9	58	2,909	1.45	0	0
		1917	126	7.5	4.1	64	5,640	2.82	725	12.9
Average			123	7.6	4.2	65	6,430	3.21	1,192	21.3
Dwarf Ashburn	S. P. I. 21936	1913	120	8.8	4.2	39	4,500	2.25	0	0
		1914	101	1.8	1.3	46	7,600	3.80	258	4.6
		1915	121	4.4	3.6	55	14,300	7.15	2,170	38.8
		1916	126	4.4	3.7	31	3,515	1.76	0	0
		1917	135	8.1	4.6	59	8,580	4.29	325	5.8
Average			121	5.5	3.5	46	7,699	3.85	551	9.8

TABLE 6.—*Agronomic data regarding sorghum varieties grown at Amarillo, Tex., for one or more seasons in the 5-year period from 1913 to 1917, inclusive*—Continued.

Variety.	Serial No.	Years grown.	Growing season (days).	Dimensions (inches).			Yields per acre			
				Row space.		Height of plants.	Air-dry forage.		Threshed seed.	
				Plant.	Stalk.		Pounds.	Tons.	Pounds.	Bushels.
Sorgos—Continued.										
Sumac	S. P. I. 35038	1913	120	6.5	3.7	38	6,189	3.09	0	0
		1914	------	1.8	1.4	58	8,061	4.03	0	0
		1915	146	7.6	4.3	108	21,900	10.95	1,350	24.1
		1916	126	2.4	2.3	38	3,174	1.59	0	0
	F. C. I. 1712	1917	145	7.1	3.9	62	8,540	4.27	0	0
Average			134	5.1	3.1	61	9,573	4.79	270	4.8
Honey	S. P. I. 34925	1913	120	7.3	4.3	51	5,933	2.97	0	0
		1914	------	3.5	2.0	61	6,075	3.04	30	.5
		1915	146	20.2	6.1	92	17,680	8.84	1,240	22.1
		1916	126	8.3	5.4	39	3,369	1.68	0	0
		1917	145	5.6	4.7	59	6,940	3.47	0	0
Average			134	9.0	4.5	60	7,999	4.00	254	4.5
Grain sorghums:										
Dwarf white kafir	C. I. 342	1913	110	10.1	7.2	27	733	.37	0	0
		1914	100	3.9	2.7	46	4,275	2.14	908	16.2
		1915	121	18.0	9.7	56	6,820	3.41	2,790	49.8
		1916	126	15.7	11.1	37	1,774	.89	0	0
		1917	145	15.1	9.3	51	3,440	1.72	770	13.8
Average			120	12.6	8.0	43	3,408	1.71	894	16.0
Dawn kafir	C. I. 340	1913	110	13.3	7.3	28	900	.45	0	0
		1914	100	7.2	3.5	45	4,825	2.41	1,153	20.6
		1915	123	8.5	4.6	61	10,000	5.00	3,960	70.7
		1916	126	8.0	5.8	37	2,422	1.21	0	0
		1917	145	11.7	6.6	51	4,740	2.37	925	16.5
Average			121	9.7	5.6	44	4,577	2.29	1,208	21.6
Sunrise kafir	C. I. 472	1913	120	8.3	4.7	30	1,333	.67	0	0
		1914	98	3.1	1.7	54	5,675	2.84	855	15.3
		1915	133	14.5	5.1	75	9,880	4.94	3,240	57.9
		1916	126	6.2	4.2	48	3,097	1.55	0	0
		1917	140	14.8	5.4	68	5,240	2.62	570	10.2
Average			123	9.4	4.2	55	5,045	2.52	933	16.7
Dwarf Blackhull kafir	S. P. I. 17569	1913	120	7.0	5.0	27	1,975	.99	0	0
		1914	117	2.7	2.3	46	5,800	2.90	121	2.2
		1915	133	14.8	7.2	72	11,320	5.66	3,530	63.0
		1916	126	20.9	9.3	44	2,401	1.20	0	0
		1917	145	32.6	20.0	60	3,580	1.79	590	10.5
Average			128	15.6	8.8	50	5,015	2.51	848	15.1
White kafir	S. P. I. 19695	1913	120	8.9	6.2	33	2,333	1.17	0	0
		1914	129	3.1	2.4	45	4,850	2.43	157	2.8
Average			125	6.0	4.3	39	3,592	1.80	79	1.4
Pink kafir	S. P. I. 19742	1913	120	8.1	6.0	33	2,967	1.48	0	0
		1914	124	2.9	2.3	49	5,750	2.88	428	7.6
		1915	133	22.0	8.2	80	11,320	5.66	3,920	70.0
		1916	126	32.9	11.2	36	1,761	.88	0	0
		1917	145	14.8	9.0	59	4,940	2.47	275	4.9
Average			130	16.1	7.3	51	5,348	2.67	925	16.5
Red kafir	S. P. I. 19492	1913	110	3.2	3.1	33	2,467	1.23	0	0
		1914	113	3.5	2.8	49	5,125	2.56	488	8.7
		1915	133	21.5	9.1	70	9,700	4.85	3,260	58.2
		1916	126	15.6	7.7	36	2,116	1.06	0	0
		1917	145	11.4	7.0	53	5,540	2.77	270	4.8
Average			125	11.0	5.9	48	4,990	2.49	804	14.3

TABLE 6.—*Agronomic data regarding sorghum varieties grown at Amarillo, Tex., for one or more seasons in the 5-year period from 1913 to 1917, inclusive*—Continued.

Variety	Serial No.	Years grown.	Growing season (days).	Dimensions (inches).			Yields per acre.			
				Row space.		Height of plants.	Air-dry forage.		Threshed seed.	
				Plant.	Stalk.		Pounds.	Tons.	Pounds.	Bushels.
Grain sorghums—Contd.										
Early White milo	F. C. I. 5886	1914	93	6.2	2.5	52	4,250	2.13	1,153	20.6
		1916	71	19.0	11.7	31	773	.39	97	1.7
		1917	89	8.6	5.4	42	1,520	.76	235	4.2
Average			84	11.3	6.5	42	2,181	1.09	495	8.8
Dwarf Yellow milo	S. P. I. 18684	1913	97	5.9	4.0	24	2,050	1.03	117	2.1
		1914	95	7.0	2.0	36	4,075	2.04	963	17.2
	C. I. 332	1915	115	11.1	3.8	51	9,390	4.70	5,200	92.9
		1916	116	16.8	11.0	28	1,656	.83	376	6.7
		1917	140	7.7	4.8	39	2,900	1.45	690	12.3
Average			113	9.7	5.1	36	4,014	2.01	1,469	26.2
Yellow milo	S. P. I. 35048	1913	97	11.0	5.9	36	2,500	1.25	200	3.6
		1914	95	7.6	2.7	48	4,675	2.34	909	16.2
Average			96	9.3	4.3	42	3,588	1.80	555	9.9
Feterita	F. C. I. 811	1913	81	11.2	5.0	34	2,200	1.10	825	14.7
		1914	91	7.8	2.6	56	5,625	2.81	1,605	28.7
		1915	108	14.8	4.3	66	7,040	3.52	2,990	53.4
		1916	116	12.1	5.4	38	1,789	.89	445	7.9
		1917	126	8.9	4.5	45	2,860	1.43	730	13.0
Average			104	11.0	4.4	48	3,903	1.95	1,319	23.5
Feterita	S. P. I 19517	1913	84	9.8	4.7	36	2,567	1.28	733	13.1
		1914	92	8.5	3.2	55	4,175	2.09	828	14.8
	S. P. I. 22329	1915	108	14.5	4.2	65	9,060	4.53	3,060	54.6
		1916	116	14.1	5.7	42	1,963	.98	320	5.7
		1917	126	14.7	5.3	50	3,980	1.99	720	12.9
Average			105	12.3	4.6	50	4,349	2.17	1,132	20.2
Dwarf hegari	S. P. I. 34911	1913	90	3.0	2.5	20	1,000	.50	0	0
		1914	88	11.0	3.6	44	4,750	2.38	1,118	20.0
		1915	108	19.5	7.2	53	6,560	3.28	2,620	46.8
		1916	126	14.9	6.0	27	2,081	1.04	0	0
Average			103	12.1	4.8	36	3,598	1.80	935	16.7
Brown kaoliang	S. P. I. 38086	1916	71	11.5	9.2	39	988	.49	184	3.3
		1917	89	10.1	6.5	51	1,480	.74	320	5.7
Average			80	10.8	7.9	45	1,234	.62	252	4.5
Freed sorghum	S. P. I. 29166	1913	84	4.6	3.7	54	1,433	.72	267	4.8
		1914	85	5.4	2.1	68	4,025	2.01	731	13.1
Average			85	5.0	2.9	61	2,729	1.37	499	9.0
Acuff sorghum	F. C. I. 1615	1916	126	14.6	7.2	25	1,580	.79	0	0
		1917	145	15.7	7.7	47	4,300	2.15	245	4.4
Average			136	15.2	7.5	36	2,940	1.47	123	2.2

TABLE 6.—*Agronomic data regarding sorghum varieties grown at Amarillo, Tex., for one or more seasons in the 5-year period from 1913 to 1917, inclusive*—Continued.

SUMMARY FOR THE MORE IMPORTANT SORGHUM VARIETIES.

Variety.	Growing season.	Row space.		Height of plants.	Yields per acre.			
		Plant.	Stalk.		Air-dry forage.		Threshed seed.	
					Average.	Relative.	Average.	Relative.
Sorgos:	*Days.*	*Inches.*	*Inches.*	*Inches.*	*Tons.*	*Per ct.*	*Bush.*	*Per ct.*
Black Amber [1]	103	9.2	3.9	65	2.44	100	21.5	100
Clubhead [2]	106	12.7	5.5	59	2.42	99	20.1	93
Red Amber	106	8.0	3.9	57	2.65	109	15.6	73
Orange	128	6.2	4.1	60	3.43	141	8.6	40
McLean	124	8.6	4.9	73	3.36	138	9.8	46
Dwarf Ashburn	121	5.5	3.5	46	3.85	158	9.8	46
Sumac	134	5.1	3.1	61	4.79	196	4.8	22
Honey	134	9.0	4.5	60	4.00	164	4.5	21
Grain sorghums:								
Dwarf White kafir	120	12.6	8.0	43	1.71	75	16.0	74
Dawn kafir [3]	121	9.7	5.6	44	2.29	100	21.6	100
Sunrise kafir	123	9.4	4.2	55	2.52	110	16.7	77
Dwarf Blackhull kafir	128	15.6	8.8	50	2.51	110	15.1	70
Pink kafir	130	16.1	7.3	51	2.67	117	16.5	76
Red kafir	125	11.0	5.9	48	2.49	109	14.3	66
Dwarf Yellow milo	113	9.7	5.1	36	2.01	88	26.2	121
Feterita (F. C. I. 811)	104	11.0	4.4	48	1.95	85	23.5	109
Feterita (S. P. I. 22329)	105	12.3	4.6	50	2.17	94	20.2	94

[1] Black Amber was chosen as the check variety of sorgo, because Sumac, though it is more generally grown in the locality adjacent to Amarillo, matured seed only one year out of the five included in the test.

[2] Clubhead sorgo was not included in the tests for 1913; hence, in order to make the average for this variety comparable with those of the others which were grown throughout the 5-year period, the yield of Black Amber in 1913 was substituted for the yield of Clubhead for that year.

[3] Dawn kafir was selected as the check for the grain sorghums because of its adaptability to conditions at Amarillo and its generally creditable performance throughout the period included in the test.

In Table 7 the yields of the less important varieties are given. These yields are compared with those of the same varieties that were used for checks in the summary of Table 6, and the relative yields are given in percentages of the check. A direct comparison is possible, therefore, between the varieties included in the two tables. No varieties of outstanding merit were found among those discussed in Table 7.

Sumac sorgo made the largest forage yields of any sorghum. This variety very rarely makes a good seed crop at Amarillo, which necessitates the purchase of a large part of the seed required for each year's seeding. The seed has to be shipped in from outside points and is not always uniform in its behavior under Amarillo conditions.

The Honey, Dwarf Ashburn, and Orange sorgos are other good forage varieties. None of them produce seed very consistently, though the Dwarf Ashburn and Orange are better in this respect than the Sumac. The Colman is a variety much like the Orange, and the results of the two years' test suggest that it is capable of making higher yields of forage than the latter variety.

Among the grain sorghums a late-maturing strain of Pink kafir made the highest yield of forage and Dwarf milo the highest yield of grain; however, the first-named variety was deficient in grain and Dwarf milo produced 12 per cent less forage than the check variety. No variety combining the two essentials, grain and fodder, was found superior to the check, Dawn kafir.

TABLE 7.—*Average yields of forage and seed of the miscellaneous varieties of sorghum grown at Amarillo, Tex., each variety being compared with a check during the 5-year period from 1913 to 1917, inclusive.*

Variety.	Serial No.	Years under test.	Variety used as a check.	Forage yields.			Seed yields.		
				Tons per acre.			Bushels per acre.		
				Variety.	Check.	Relative, percentage of check.	Variety.	Check.	Relative, percentage of check.
Sorgos:									
Dwarf Amber	F. C. I. 6586	1914 to 1917.	Black Amber	1.83	2.84	64	21.4	25.3	85
Whooper	F. C. I. 5873	1916 and 1917.	do	1.03	1.88	55	5.1	14.3	36
Collier	S. P. I. 21807	1914 and 1915	do	3.98	3.80	105	28.3	36.3	78
Colman	S. P. I. 34986	1913 and 1914.	do	3.12	1.74	179	1.3	13.7	9
Kansas Straightneck.	F. C. I. 02224	1915 to 1917.	do	4.26	2.90	147	12.4	26.8	46
Johnson grass × sorgo.	F. C. I. 5849	1915 to 1917.	do	3.21	2.90	111	21.3	26.8	79
Grain sorghums:									
White kafir	S. P. I. 19695	1913 and 1914.	Dawn kafir	1.80	1.43	126	1.4	10.3	14
Early White milo	F. C. I. 5886	1914, 1916, and 1917.	do	1.09	2.00	55	8.8	12.4	71
Dwarf hegari	S. P. I. 34911	1913 to 1916.	do	1.80	2.27	79	16.7	22.8	73
Brown kaoliang	S. P. I. 38086	1916 and 1917.	do	.62	1.79	35	4.5	8.3	54
Freed sorghum	S. P. I. 29166	1913 and 1914.	do	1.37	1.43	96	9.0	10.3	87
Acuff sorghum	F. C. I. 1615	1916 and 1917.	do	1.47	1.79	82	2.2	8.3	27

Feterita (F. C. I. No. 811), the variety which made the largest grain yield at Chillicothe, Tex., was second to Dwarf milo at Amarillo, although it outyielded the latter variety every year except 1915, when climatic conditions were unusually favorable. In 1913 under very unfavorable climatic conditions feterita was the only grain sorghum to make a measurable yield of seed. It would appear, therefore, that of the two varieties Dwarf milo has the ability to respond more effectively to favorable conditions, while feterita is more likely to produce a crop in dry years.

WOODWARD, OKLA.[9]

Weather records show that the rainfall at Woodward is somewhat heavier than at Amarillo, Tex. The normal seasonal rainfall, however, is not very different. During the period from 1915 to 1921, however, the average seasonal rainfall was more than 1.5 inches above the normal, although in some years this rainfall was not well distributed. (See Table 1.) In 1916, for example, more than 10 of the 17 inches of rain received during the growing season fell in June, the other months being exceptionally dry. Another poor season, especially for grain, was 1918, when the rainfall was deficient in the latter part of the growing season.

The field station at Woodward is 1,900 feet above sea level and located in the heart of the sorghum belt. The climate is well suited

[9] The sorghum experiments at Woodward and Lawton, Okla., Dalhart and Big Spring, Tex., and Tucumcari, N. Mex., are all conducted under a cooperative agreement with the Office of Dry-Land Agriculture of the Bureau of Plant Industry. The cooperative agreement covering the tests of grain-sorghum varieties at these stations is between the Office of Cereal Investigations and the Office of Dry-Land Agriculture. Through the courtesy of the former office the records of these grain sorghums are included, in order that they may be compared with the sorgos as to their forage value.

to sorghums except for the tendency toward a low July rainfall. (See fig. 3.) This period of low summer rainfall, however, is much shorter than at Chillicothe, Tex., where it extends over the three months, July, August, and September. Most of the sorgos except such long-season varieties as Honey and Gooseneck will mature at Woodward. The sandy soil at this station allows deeper penetration of the moisture than do the heavier soils at the other stations, and therefore the sorghums do not suffer so quickly from drought.

Dwarf milo when seeded late, about June 1 to 15, has made the highest yields of grain, but Sunrise kafir is recommended where a variety is wanted which will make satisfactory yields of both grain and fodder.

Table 8 gives for each year the actual and relative yields of the varieties included in the tests. Sumac is used as the check for sorgos and Sunrise kafir for grain sorghums.

TABLE 8.—*Comparative yields of the different sorghum varieties grown at Woodward, Okla., for the 7-year period from 1915 to 1921, inclusive.*

Variety.	1915	1916	1917	1918	1919	1920	1921	Average.	Relative; percentage of check.
Field-cured forage per acre (tons):									
Sorgos—									
Sumac	6.95	3.72	7.91	2.45	2.78	3.97	2.91	4.38	100
Orange	7.54	3.35	5.40	1.95	2.48	3.25	4.00	4.00	91
Honey	6.62	2.68	8.33	1.65	3.73	6.07	6.66	5.11	117
Red Amber	4.50	3.02	3.17	1.55	2.03	2.84	2.69	2.83	65
Black Amber			3.23	1.33	1.93	1.88	2.44	2.16	54
Grain sorghums [1]—									
Dawn kafir	4.66	1.15	4.25	1.58	3.49	2.95	2.42	2.93	81
Sunrise kafir	5.29	1.78	5.06	1.69	4.66	3.94	2.93	3.62	100
Blackhull kafir	3.26	.88	2.93	1.44	2.48	1.94	2.12	2.15	59
White kafir	2.86	.77	2.70	1.17	2.30	1.77	1.66	1.89	52
Red kafir	4.01	1.28	4.15	1.40	2.30	2.42	2.93	2.64	73
Yellow milo	4.11	1.78	2.90	1.10	4.28	3.84	3.32	3.05	84
White milo	4.73	1.31	2.99	1.13	4.65	3.99	3.23	3.15	87
Dwarf Yellow milo	5.13	1.15	2.33	.80	2.45	2.84	3.20	2.56	71
Feterita	2.90	.77	2.03	.90	3.29	2.95	3.23	2.30	64
Blackhull kaoliang	2.90	1.60	2.41	1.30	1.94	2.05	1.69	1.98	55
Manchu kaoliang	2.61	1.06	1.31	.99	1.46	1.45	1.18	1.44	40
Valley kaoliang	2.77	1.33	1.22	.98	1.41	2.03	1.13	1.55	43
Shallu	3.17	1.78	3.08	1.42	1.73	1.91	2.28	2.20	61
Freed sorghum	3.37	1.25	1.88	1.10	1.48	.75	1.36	1.60	44
Schrock sorghum	6.25	2.42	3.35	1.53	2.40	3.31	2.67	3.13	86
Darso sorghum	5.65	2.01	2.80	1.03	2.65	2.78	2.22	2.73	75
Threshed grain per acre (56-pound bushels):									
Sorgos—									
Sumac			27.7	1.8	10.2	29.0	18.3	17.4	100
Orange			24.9	2.0	10.4	27.5	31.5	19.3	111
Honey			0	0	3.4	16.1		4.9	28
Red Amber			26.8	10.8	15.4	17.2	28.1	19.7	113
Black Amber			25.3	7.6	23.2	18.8	29.5	20.9	120
Grain sorghums [1]—									
Dawn kafir	41.5	3.9	36.0	8.3	32.6	34.8	34.2	27.3	89
Sunrise kafir	41.8	6.6	39.5	10.3	40.4	37.9	37.7	30.6	100
Blackhull kafir	24.2	2.6	23.9	8.7	22.5	22.9	29.4	19.2	63
White kafir	26.9	8.6	28.5	6.2	21.9	20.9	28.0	20.1	66
Red kafir	37.2	3.1	32.1	7.8	23.1	28.2	37.4	24.1	79
Yellow milo	20.8	13.2	20.1	2.5	42.6	30.3	40.2	24.2	79
White milo	22.5	6.3	19.6	2.4	38.4	29.8	35.3	22.0	72
Dwarf Yellow milo	38.7	10.3	16.4	2.9	26.7	27.3	43.1	23.6	77
Feterita	26.0	7.9	14.2	6.6	40.7	30.3	42.8	24.1	79
Blackhull kaoliang	32.9	15.8	19.0	11.2	21.1	20.3	21.4	20.2	66
Manchu kaoliang	31.5	13.8	3.0	10.4	16.4	13.6	9.6	14.0	46
Valley kaoliang	35.7	17.1	3.5	10.4	16.5	26.8	11.6	17.4	57
Shallu	24.0	4.6	23.6	.3	20.1	18.9	29.7	17.3	57
Freed sorghum			8.0	6.3	16.1	8.7	14.3	10.7	32
Schrock sorghum			27.6	2.9	23.2	33.3	28.6	23.1	70
Darso sorghum			26.8	6.0	31.3	28.6	26.1	23.8	72

[1] The forage and grain yields of all the grain sorghums except Freed, Schrock, and Darso are quoted from Department Bulletin 1175 (*11*), the bushel yields being translated into bushels of 56 pounds in order to provide an exact comparison with the grain yields of the sorgos.

The data given in Table 8 fully demonstrate the value of Sumac sorgo as a forage crop in the district tributary to Woodward, Okla. This variety, although it produced somewhat less forage than Honey, made a reasonable seed crop in four years out of five, while the latter variety produced a good crop of seed in only one year of this period.

Orange sorgo made a good yield of forage and produced more seed than Sumac. These two varieties, Sumac and Orange, have good performance records in the tests and make up a very large part of the sweet-sorghum acreage in northwestern Oklahoma.

Red Amber is perhaps the best early-maturing variety of sorgo, and it will produce seed in the driest years; but, like all early varieties, it does not make a very high yield of forage.

Schrock and Darso sorghums are both hybrid varieties which originated in Oklahoma and are well adapted to conditions in that State. They are not equal to the sorgos, however, as forage producers and are much inferior to the Sunrise and Dawn kafirs in both quantity and quality of grain. Sunrise kafir is the outstanding variety of grain sorghum for forage purposes and has also produced the highest average grain yield.

LAWTON, OKLA.

On account of its proximity to Fort Sill, weather records are available at Lawton for a total of 46 years. These records indicate that the normal annual rainfall at Lawton is 5 inches greater than that at Chillicothe. (See fig. 3 and Table 1.) May, with an average of 5 inches, is normally the month of greatest rainfall. During the period from 1917 to 1921, however, the average for October was 2 inches higher than that of May, principally because of the excessive precipitation in October, 1919. (See Table 1.) The extreme uncertainty of the rainfall at Lawton is illustrated by the October rainfall, which has varied from 0.03 of an inch in 1921 to 13.78 inches in 1919.

The normal amount and distribution of rainfall at Lawton is favorable to the production of splendid crops of sorghum. (See Table 1 and fig. 3.) In individual years, however, the variation from normal is sometimes so great that crop failure is unavoidable. This happened in 1918, when an unusually dry autumn in 1917 was followed by a dry spring, there being very little effective rainfall from August, 1917, to June, 1918. The result of this long dry period was a low yield of forage and no grain.

Lawton has an altitude of 1,111 feet and, like Woodward, Okla., is located well within the sorghum belt. Sumac and Orange sorgos and Blackhull kafir mature regularly except in years when their development is retarded by periods of drought.

The actual and relative yields of grain and forage for each year from 1917 to 1921 are given in Table 9. These data include the principal sorgos and many varieties of grain sorghum, Sumac sorgo and Dawn kafir being used as the respective checks.

Honey sorgo made the highest yield of forage during the test period but produced seed only one year. Orange sorgo was second in forage and matured seed three years. Sumac sorgo did equally well, producing only slightly less forage than Orange and a little more seed.

TABLE 9.—*Comparative yields of the different sorghum varieties grown at Lawton, Okla., for the 5-year period from 1917 to 1921, inclusive.*

Variety.	1917	1918	1919	1920	1921	Average.	Check.	Relative; percentage of check.
Field-cured forage per acre (tons):								
Sorgos—								
Sumac	2.13	2.77	7.53	9.03	5.73	5.44	5.44	100
Orange	2.52	2.52	7.93	8.66	6.66	5.66	5.44	104
Honey	1.57	1.99	7.93	12.13	7.35	6.19	5.44	114
Red Amber	.97	.89	3.85	3.28	2.81	2.36	5.44	43
Black Amber	1.09	1.53	3.85	3.58	4.22	2.85	5.44	52
African millet				7.25	4.95	6.10	7.38	83
Grain sorghums—								
Dawn kafir	2.73	1.50	4.78	3.15	2.53	2.94	2.94	100
Sunrise kafir	2.49	1.30	4.88	4.28	3.47	3.28	2.94	112
Blackhull kafir	2.98	1.25	5.05	3.43	2.72	3.09	2.94	105
Red kafir	2.54	1.54	4.44	3.30	2.66	2.90	2.94	99
Bishop kafir				2.66	3.06	2.86	2.84	101
Dwarf Yellow milo	1.22	.59	5.05	2.90	0	1.95	2.94	66
Yellow milo	1.24	1.37	6.10	2.65	0	2.27	2.94	77
White milo	1.06	1.20	5.10	2.85	0	2.04	2.94	69
Feterita	1.43	.94	3.90	2.75	0	1.80	2.94	61
Spur feterita				3.43	1.47	2.45	2.84	86
Freed sorghum	.68	.73	3.20	1.60	3.19	1.88	2.94	64
Darso sorghum	1.53	1.13	4.48	4.42	3.85	3.08	2.94	105
Shallu	2.95	1.12	4.18	3.78	2.63	2.93	2.94	100
Manchu kaoliang	.83	.80	2.95	2.23	.50	1.46	2.94	50
Husser sorghum				5.44	3.91	4.68	2.84	165
Threshed grain per acre (56-pound bushels):								
Sorgos—								
Sumac	0	0	29.5	30.7	37.5	19.5	19.5	100
Orange	0	0	29.1	24.0	25.0	15.6	19.5	80
Honey	0	0	29.1	0	0	5.8	19.5	30
Red amber	5.4	0	32.1	25.6	25.7	17.8	19.5	91
Black amber	5.7	0	33.0	29.6	38.6	21.4	19.5	110
African millet				38.8	33.0	35.9	34.1	105
Grain sorghums—								
Dawn kafir	15.4	0	48.0	33.0	28.1	24.9	24.9	100
Sunrise kafir	17.2	0	39.6	29.5	19.6	21.2	24.9	85
Blackhull kafir	26.3	0	55.4	36.1	31.5	29.9	24.9	120
Red kafir	19.6	0	44.1	33.2	28.8	25.1	24.9	101
Bishop kafir				50.0	45.1	47.6	30.6	156
Dwarf Yellow milo	11.4	0	45.0	29.6	0	17.2	24.9	69
Yello milo	8.8	0	40.9	20.4	0	14.0	24.9	56
White milo	8.7	0	38.0	17.0	0	12.7	24.9	51
Feterita	12.1	4.5	44.3	29.6	0	18.1	24.9	73
Spur feterita				29.7	8.3	19.0	30.6	62
Freed sorghum	7.3	0	31.3	6.8	16.7	12.4	24.9	50
Darso sorghum	7.5	0	62.1	49.6	42.1	32.3	24.9	130
Shallu	22.2	0	46.1	22.4	13.4	20.8	24.9	84
Manchu kaoliang	7.9	1.8	40.2	24.0	4.9	15.8	24.9	63
Husser sorghum				50.0	29.9	40.0	30.6	131

Among the generally recognized grain sorghums, Blackhull kafir and a local variety known as Bishop kafir (a selected strain of Blackhull) made the best record if both forage and grain are considered. Bishop kafir gave such good results for the two years 1920 and 1921 that it has been included in the record of these experiments. Milo made a poor showing at Lawton on account of its susceptibility to injury from chinch bugs. The milo crop was completely destroyed by these insects in 1921.

Husser sorghum, a hybrid, did well in 1920 and 1921, making 7 bushels less grain per acre than Bishop kafir, but nearly 2 tons more fodder.

DALHART, TEX.

Weather records covering the period from 1908 to 1921 (see fig. 3 and Table 1) indicate an unusually favorable distribution for the production of sorghums; 78 per cent of the yearly rainfall occurs during the growing season. The rainfall during the period covered

by these tests was 1 inch above normal, and if it had been properly distributed it would have been sufficient every year except 1917 to produce a good crop. In fact, sorghum has proved to be the most dependable crop at Dalhart, both forage and grain. The small yields in 1918 resulted from the small amount of rain received during the last four months of 1917 as well as the low rainfall in June, July, and August, 1918. The last three years, 1919 to 1921, were exceptionally favorable during the growing seasons and the yields were above the average.

Dalhart is located on the high plains of northwestern Texas, having an altitude of 4,000 feet. This altitude shortens the season somewhat and interferes with seed production in some of the late varieties, such as Sumac and Honey.

The actual and relative yields of grain and forage for each year from 1916 to 1921 are given in Table 10. Sumac is used as the check variety for the sorgos; and Sunrise kafir was chosen as the check for the grain sorghums, because it has seemed better adapted to Dalhart conditions than Dawn kafir.

TABLE 10.—*Comparative yields of the different sorghum varieties grown at Dalhart, Tex., for the 6-year period from 1916 to 1921, inclusive.*

Variety.	1916	1917	1918	1919	1920	1921	Average.	Check.	Relative; percentage of check.
Field-cured forage per acre (tons):									
Sorgos—									
Sumac		0.96	2.38	5.84	5.48	7.46	4.42	4.42	100
Orange		1.08	1.88	5.36	4.98	4.22	3.50	4.42	79
Honey		.98	1.81	7.30	6.65	4.15	4.18	4.42	95
Red Amber		1.10	1.34	3.58	3.61	3.06	2.54	4.42	57
Black Amber		1.24	1.31	3.70	3.40		2.41	3.67	66
Grain sorghums—									
Dawn kafir	2.00		2.00	2.78	2.69	3.09	2.51	2.87	87
Sunrise kafir	2.80	1.03	2.05	3.44	2.77	3.31	2.57	2.57	100
Blackhull kafir	2.21		2.30	3.55	3.10	3.97	3.03	2.87	106
Red kafir	1.93		1.13	3.28	2.50	3.48	2.46	2.87	86
Dwarf Yellow milo	1.68		1.35	3.63	2.68	3.38	2.54	2.87	89
Yellow milo	1.95		1.70	3.77	3.16	3.06	2.73	2.87	95
White milo	1.65		1.60	3.73	3.20		2.55	2.77	92
Feterita	1.35		1.18	2.21	3.03	2.56	2.07	2.87	72
Spur feterita				3.15	2.29	2.50	2.65	3.17	84
Dwarf hegari				3.03	1.98	3.19	2.73	3.17	86
Freed sorghum		.64	.98	3.35	3.00	2.78	2.15	2.52	85
Darso sorghum		.93	1.35	3.62	3.63	3.91	2.69	2.52	107
Shallu	1.75		1.25	2.73	2.68	2.33	2.15	2.87	75
Manchu kaoliang			1.13	2.85	2.47		2.15	2.77	78
Threshed grain per acre (56-pound bushels):									
Sorgos [1]—									
Sumac					0	18.2	9.1		
Orange				15.7	0	18.5	11.4		
Honey				13.0	0	3.6	5.5		
Red Amber			9.3	26.1	24.6	31.7	22.9		
Black Amber			8.0	14.6	26.2		16.3		
Grain sorghums—									
Dawn kafir	14.8		5.2	26.1	27.7	25.7	19.9	23.3	85
Sunrise kafir	14.6		4.6	38.6	28.0	30.8	23.3	23.3	100
Blackhull kafir	4.9		10.0	42.0	0	34.4	18.3	23.3	79
Red kafir	2.5		2.7	19.6	13.4	13.8	10.4	23.3	45
Dwarf Yellow milo	21.8			55.5	38.6	46.2	40.5	28.0	145
Yellow milo	16.4		7.1	48.9	67.0	33.5	34.6	23.3	148
White milo	13.4		2.1	48.6	69.6		33.4	21.5	155
Feterita	17.3		6.8	33.6	28.6	27.9	22.8	23.3	98
Spur feterita				36.4	25.0	29.3	30.2	32.5	93
Dwarf hegari				47.1	25.8	40.6	37.8	32.5	116
Freed sorghum			10.0	44.6	29.4	31.9	29.0	25.5	114
Darso sorghum				40.2	22.7	21.2	28.0	32.5	86
Shallu	0		0	27.7	22.1	14.6	12.9	23.3	55
Manchu kaoliang			12.9	29.5	16.8		19.7	23.7	83

[1] No relative yields for the sorgos are given, because grain yields for Sumac sorgo were obtained for two years only.

Sumac sorgo proved to be the best forage variety, with Honey second. Neither of these varieties produces very large yields of seed at Dalhart, but they ordinarily mature sufficiently to make a good quality of fodder. Seed yields have not been obtained consistently from the sweet sorghums; hence, no accurate estimate is possible of a given variety's dependability in producing seed for sowing. This item is less important in sorghum culture than with many other crops on account of the small quantity of seed required.

In the grain-sorghum class only two of the varieties made larger yields of forage than Sunrise kafir, and this difference was small, 7 per cent in the case of Darso and 6 per cent for Blackhull kafir. In yield of grain, however, the milos, both Yellow and White, exceeded Sunrise kafir approximately 50 per cent. Freed sorghum made a better relative showing at Dalhart than at any other point in the sorghum belt, and this variety can be used to advantage here for late seeding.

BIG SPRING, TEX.

The weather records at Big Spring cover a period of 22 years from 1900 to 1921. The normal rainfall is very low and, although a large proportion of it comes during the growing season, the variation in the total received annually is so great that in many years it is impossible to grow even such drought-resistant crops as the sorghums. (See fig. 3 and Table 1.) This explains the crop failures in 1917 and 1918 when the seasonal rainfall was 4.25 and 6.88 inches, respectively. Even the native vegetation was unable to make any growth in these two years, and stock raisers were left with practically no forage, compelling them to ship large numbers of cattle out of this part of Texas. The total rainfall in 1921 was less than that of 1918, but the good rains received during May and June resulted in a fair crop of sorghum.

Big Spring has an altitude of 2,396 feet and is located on slightly rolling land. This station is on the southern edge of the sorghum belt, where climatic conditions make crop production precarious unless water is available for irrigation. Under these conditions cotton, sorghum, and cowpeas are the most dependable crops.

The actual and relative yields of forage for each year from 1915 to 1921 are given in Table 11. Grain yields are available only for the grain sorghums. Sumac sorgo was again used as a check for the sorgos and Dawn kafir for the grain sorghums. All of the sorghums included in these experiments will mature at Big Spring consistently unless their growth is checked by a period of acute drought during the summer.

Honey and White African sorgos made the largest yields of forage, with Sumac a close second. The latter variety is more largely grown than the others, because seed of it is more easily obtained. The early varieties can not compete with later ones, such as Sumac and Honey, at Big Spring, where the length of the growing season is not a factor in determining values.

Some unexpected results were obtained in the grain-sorghum tests. Schrock sorghum, Yellow milo, and Dwarf hegari, in the order named, were leaders in forage production. Through a misunderstanding, no grain yields were recorded for the varieties included in the test of

forage sorghums; and as Schrock, a hybrid sorghum, was included in this part of the experiment, no grain yields are available for it.

Dawn kafir made the largest yield of grain, although Dwarf Yellow milo nearly equaled it. These two varieties are apparently the best grain sorghums for this region.

TABLE 11.—*Comparative yields of the different sorghum varieties grown at Big Spring, Tex., for the 7-year period from 1915 to 1921, inclusive.*

Variety.	1915	1916	1917	1918	1919	1920	1921	Average.	Check.	Relative; percentage of check.
Field-cured forage per acre (tons):										
Sorgos [1]—										
Sumac	10.01	3.25	0	0.39	4.53	7.75	3.30	4.18	4.18	100
Orange	6.48	1.88	0	.36	4.78	4.67	2.35	2.93	4.18	70
Honey	7.87	6.53	0	.30	4.60	9.88	2.49	4.52	4.18	108
Red Amber	4.56	2.00	0	.50	3.41	3.60	1.98	2.29	4.18	55
Black Amber	3.03	1.65	0	.41	3.56	3.49	1.87	2.00	4.18	48
Seeded Ribbon Cane					5.31	4.88	2.30	4.16	5.19	80
White African		3.38	0	.31	5.29	8.55	3.14	3.45	3.20	108
Grain sorghums—										
Dawn kafir	4.11	1.67	0	1.12	3.49	3.08	1.75	2.17	2.17	100
Sunrise kafir	3.55	2.70	0	.74	4.18	2.57	2.10	2.26	2.17	104
Blackhull kafir		2.11	0	.83	3.56	3.85	1.78	2.02	1.85	109
Red kafir	2.52	1.12	0	.65	4.06	2.98	1.56	1.84	2.17	85
Dwarf Yellow milo	5.18	1.14	0	.54	2.38	3.63	2.07	2.13	2.17	98
Yellow milo	4.26	2.94	0	1.15	3.00	4.73	2.05	2.59	2.17	119
White milo	4.05	2.29	0	.49	2.52	2.58	1.81	1.96	2.17	90
Feterita	2.19	1.87	0	.32	1.73	2.79	1.63	1.50	2.17	69
Dwarf hegari		4.46	0	1.17	1.89	3.80	1.50	2.14	1.85	116
Freed sorghum	2.34	2.71	0	1.13	3.02	2.20	1.74	1.88	2.17	87
Darso sorghum		2.59	0	.29	3.49	3.00	1.57	1.82	1.85	98
Schrock sorghum		2.95	0		4.16	3.58	1.73	2.48	1.85	134
Shallu		2.30	0	.90	2.84	4.85	1.45	2.06	1.85	111
Manchu kaoliang	.98				2.16	2.67	1.09	1.73	3.11	56
Blackhull kaoliang					2.34	1.79	1.33	1.82	2.77	66
Threshed grain per acre (56-pound bushels):										
Grain sorghums—										
Dawn kafir	40.3	15.2	0	3.0	48.0	41.5	20.9	24.1	24.1	100
Sunrise kafir	26.4	28.2	0	.3	38.1	31.8	35.6	22.9	24.1	95
Blackhull kafir		18.4	0	0	39.2	44.6	18.9	20.2	21.4	94
Red kafir	22.9	10.8	0	.6	43.7	32.0	16.3	18.0	24.1	75
Dwarf Yellow milo	47.0	7.9	0	2.8	37.3	39.6	29.8	23.5	24.1	98
Yellow milo	28.6	22.8	0	3.3	39.5	39.9	19.0	21.9	24.1	91
White milo	25.0	16.1	0	5.3	36.3	26.1	19.4	18.3	24.1	76
Feterita	33.3	22.9	0	.6	20.7	23.1	18.9	17.1	24.1	77
Dwarf hegari					28.2	34.7	0	21.0	36.8	57
Shallu		24.6	0	.7	25.5	55.5	8.2	19.1	21.4	89
Manchu kaoliang	12.9				23.9	18.8	16.8	18.1	37.7	48
Blackhull kaoliang					33.0	27.4	20.2	26.9	36.8	73

[1] Grain yields were not obtained from any of the sorgos, nor from Freed, Darso, and Schrock sorghums.

TUCUMCARI, N. MEX.

Climatic conditions at Tucumcari, where the normal annual rainfall is only 17.4 inches, resemble those at Big Spring, Tex., not only in respect to the total, but also as regards the variation in seasonal rainfall. A slightly larger proportion of the total rainfall comes during the growing season at Tucumcari; soil blowing is also a factor of more importance than at Big Spring. On the whole, therefore, the chances of getting a profitable crop are about equal at the two places and considerably less than at Dalhart, Tex., where the total rainfall is about the same.

Tucumcari is nearer the mountains and has a higher altitude (4,194 feet) than any of the other field stations in the sorghum belt. This altitude, however, when considered in connection with the latitude is not sufficient to limit sorghum production.

The actual and relative yields of forage for each year from 1914 to 1921 are given in Table 12. Grain yields were not obtained consistently for the sorgos and are therefore available only for the grain sorghums. Sumac is used as a check for the sorgo varieties and Dawn kafir for the grain sorghums. The growing season is sufficiently long at Tucumcari for varieties like Blackhull and Red kafir.

TABLE 12.—*Comparative yields of the different sorghum varieties grown at Tucumcari, N. Mex., for the 8-year period from 1914 to 1921, inclusive.*

Variety.	1914	1915	1916	1917	1918	1919	1920	1921	Average.	Check.	Relative; percentage of check.
Field-cured forage per acre (tons):											
Sorgos—											
Sumac	6.02	6.03	6.57	5.43	0.65	4.10	2.55	3.85	4.40	4.40	100
Orange	3.50	4.10	4.87	3.69	1.40	------	1.41	4.50	3.35	4.44	75
Honey	6.13	5.89	6.31	5.77	1.25	5.25	2.22	4.94	4.72	4.40	107
Red Amber	3.51	4.20	2.28	2.87	.60	1.70	1.28	1.81	2.28	4.40	52
Black Amber	3.06	4.26	2.32	2.42	.63	1.05	------	------	2.29	4.80	48
Dakota Amber	------	------	1.64	2.20	------	------	------	3.2	------	------	------
Dwarf Ashburn	------	------	5.30	4.83	------	------	------	8.5	------	------	------
McLean	------	------	3.59	5.75	------	------	------	7.8	------	------	------
Collier	------	------	2.71	3.20	------	------	------	4.9	------	------	------
Whooper	------	------	2.14	3.13	------	------	------	4.4	------	------	------
Grain sorghums—											
Dawn kafir	[1]2.17	2.95	1.48	1.71	.10	1.58	1.38	1.66	1.63	1.63	100
Sunrise kafir	2.79	------	1.68	2.32	.28	1.90	1.51	2.50	1.85	1.44	128
Blackhull kafir	------	3.00	1.82	2.07	.43	1.70	1.74	2.44	1.89	1.55	122
Red kafir	------	2.97	2.00	2.31	.15	2.05	1.44	------	1.82	1.53	119
Dwarf Yellow milo	3.15	1.92	1.16	.78	.28	1.20	1.03	1.72	1.41	1.63	87
Yellow milo	2.98	1.80	1.52	1.32	.45	.73	1.23	------	1.43	1.62	88
White milo	2.92	2.00	1.62	1.06	.55	.90	1.44	------	1.50	1.62	93
Feterita	2.91	2.06	1.12	1.20	.13	1.05	1.23	1.05	1.34	1.63	82
Spur feterita	------	------	------	------	------	1.40	1.59	2.31	1.77	1.54	115
Dwarf hegari	------	------	2.75	3.06	------	------	------	1.56	2.46	1.62	152
Freed sorghum	2.51	2.82	1.47	1.36	.10	1.20	.85	------	1.47	1.62	91
Schrock sorghum	------	2.73	3.25	4.60	------	------	------	------	3.53	2.05	172
Darso sorghum	------	3.71	1.64	2.45	------	2.15	1.66	1.86	2.25	1.79	126
Shallu	------	------	1.12	1.97	.40	1.80	1.57	1.50	1.39	1.32	105
Manchu kaoliang	1.27	1.57	------	.69	.28	------	.90	------	.94	1.66	57
Threshed grain per acre (56-pound bushels):											
Dawn kafir	[1]26.0	41.7	14.3	18.2	0	15.0	14.7	16.8	18.3	18.3	100
Sunrise kafir	32.3	------	14.3	21.7	0	15.8	18.0	28.8	18.7	15.0	125
Blackhull kafir	------	31.6	7.9	12.4	0	18.1	9.8	27.0	15.3	17.2	89
Red kafir	------	34.0	8.9	18.9	0	17.4	12.7	29.5	17.3	17.2	100
Dwarf Yellow milo	47.0	26.5	13.5	8.4	0	6.8	15.4	18.9	17.1	18.3	93
Yellow milo	38.8	17.5	12.7	8.4	0	4.0	14.5	------	13.7	18.6	74
White milo	39.3	19.3	13.5	9.9	0	3.4	19.1	------	14.9	18.6	80
Feterita	39.1	23.1	12.6	9.3	0	5.8	20.0	11.3	15.2	18.3	83
Spur feterita	------	------	------	------	------	9.6	22.2	24.3	18.7	15.5	121
Dwarf hegari	------	------	15.7	29.2	------	------	------	19.6	21.5	16.4	131
Freed sorghum	------	------	8.8	15.4	0	10.3	5.7	------	8.0	12.4	65
Schrock sorghum	------	------	22.1	19.2	------	------	------	------	20.7	16.3	127
Darso sorghum	------	------	13.8	21.6	------	20.1	20.9	25.0	20.3	15.8	128
Shallu	------	------	------	14.9	0	14.8	17.4	25.0	14.4	12.9	112
Manchu kaoliang	19.8	14.9	------	5.4	0	------	15.0	------	11.0	20.1	55

[1] Interpolated yields. (Yield of Dawn kafir in 1914 : yield of Sunrise kafir in 1914 : : average yield of Dawn kafir, 1916 to 1921 : average yield of Sunrise kafir, 1916 to 1921.)

Honey sorgo made the largest yield of forage, with Sumac second, the relation between these two varieties at Tucumcari being almost the same as at Big Spring, Tex. Here, also, the availability of seed makes Sumac the more popular variety among farmers. Early varieties do not yield so much forage as the later ones and are of little importance in this region except for late seeding.

It is difficult to decide from the data which are the leading varieties of grain sorghum. From a forage standpoint Schrock sorghum,

Dwarf hegari, and Sunrise kafir have made the best records. In grain production Dwarf hegari leads, with an average yield 31 per cent larger than the check. Next in relative yield are the Darso and Schrock sorghums, both hybrids with seed of somewhat lower feeding value than either of the other two varieties. Sunrise kafir and Dwarf hegari deserve consideration as dual-purpose sorghums, even though Dwarf milo is generally recognized as the leading grain sorghum in northeastern New Mexico.

NORTHERN GREAT PLAINS.

Sorghums are of little importance in this region outside of South Dakota. The limiting factors are both temperature and rainfall and in contrast to conditions in the southern Plains temperature is perhaps the most important. Only very short season varieties, like the Dakota Amber, mature with any degree of regularity, and even that variety is injured frequently by frost in the Judith Basin. Corn is preferred by farmers on account of its ability to grow at lower temperatures than sorghum and also because it usually produces some grain. This is true even in most parts of South Dakota, where the sorghums outyield corn.

The fodder yields obtained from sorghum varieties on departmental field stations in the Northern Plains are given in Table 13. Forage yields are also given for corn, in order that a direct comparison may be made of corn and sorghum under these conditions.

The results at Redfield, Ardmore, and Newell, S. Dak., and at Sheridan, Wyo., plainly indicate that the early varieties of sorghum will produce larger yields of fodder than corn in South Dakota and the lower altitudes of northeastern Wyoming. Where sorghums will mature and make from 25 to 50 per cent larger yields than corn they should be used as silage and fodder crops in preference to the latter.

In most parts of North Dakota and Montana corn ordinarily equals or surpasses the sorghums in forage yields. Minnesota Amber and Red Amber both outyielded corn slightly at Mandan, N. Dak.; but neither of these varieties matured regularly, and immature sorghum fodder is poor in quality. The Dakota Amber sorgo matures in most seasons at Mandan, but its yields of fodder are almost exactly the same as those of corn.

The difficulties attending the growing of sorghum in the Northern Plains are not fully apparent in the table of yields. Even at Redfield and Ardmore the Red Amber sorgo can not be depended upon to produce viable seed for the next year's crop. Farmers growing this variety would therefore be forced to ship in their seed from points farther south or east. Red Amber usually heads in South Dakota and develops sufficiently to make a fairly good quality of fodder. It seems probable, therefore, that the larger yields of Red Amber would justify the yearly purchase of seed.

At the Judith Basin Field Station, Moccasin, Mont., the Dakota Amber sorgo has been under test for seven years and has never fully matured. In 1916 it had reached a height of only 12 inches when cut September 15, and in 1921 was only 2 to 3 feet high when struck by a killing frost September 9.

At Havre, Mont., the results have been similar to those at Moccasin, and the average yield is only half that of corn.

TABLE 13.—*Forage yields of sorghum varieties and of corn grown at eight stations in the northern Great Plains area, for one or more seasons in the 9-year period from 1914 to 1922, inclusive.*

[The official titles for certain of these field stations are as follows: At Newell, S. Dak., the Belle Fourche Field Station; at Mandan, N. Dak., the Northern Great Plains Field Station; at Moccasin, Mont., the Judith Basin Field Station. The fodder was field cured, except that all yields at Havre, Mont., and those for 1922 at Redfield, S. Dak., are on an air-dry basis. The yields given in the "Average of corn" column are the average yields of corn for the years in which the sorghum variety opposite was grown.]

Station and variety.	Yields of fodder per acre (tons).									Average of—		Sorghum percentage of corn.
	1914	1915	1916	1917	1918	1919	1920	1921	1922	Sorghum.	Corn.	
Redfield, S. Dak.:												
Dakota Amber sorgo	4.45	------	3.89	2.50	------	3.07	4.22	3.35	2.74	3.46	3.04	114
Minnesota Amber sorgo	4.44	------	5.61	3.55	------	3.48	6.48	5.20	3.16	4.56	3.04	150
Red Amber sorgo	5.65	------	7.36	4.75	------	4.55	7.74	5.79	3.01	5.55	3.04	183
Early White milo	------	------	4.91	2.51	------	3.06	5.33	4.80	2.82	3.91	3.20	122
Brown kaoliang	2.39	------	------	------	------	2.26	3.25	2.78	3.23	2.78	2.94	95
Kaoliang × sorgo	------	------	------	------	------	------	7.62	8.29	3.58	6.50	3.51	185
Freed sorghum	2.12	------	------	------	------	3.59	5.75	4.41	2.08	3.59	2.94	122
Husser sorghum	------	------	------	------	------	------	6.81	4.41	2.50	4.57	3.51	130
Corn	2.11	------	4.38	[1]2.20	------	2.07	3.88	4.77	1.89	------	3.04	------
Ardmore, S. Dak.:												
Dakota Amber sorgo	------	4.15	3.43	------	2.93	1.97	1.83	------	------	2.86	2.18	131
Minnesota Amber sorgo	------	5.75	4.05	------	3.65	2.65	2.40	------	------	3.70	2.18	170
Red Amber sorgo	------	5.23	6.62	------	4.04	3.19	2.71	------	------	4.36	2.18	200
Orange sorgo	------	7.60	5.61	------	4.74	------	------	------	------	5.98	2.73	219
Blackhull kafir	------	5.68	3.33	------	3.22	1.50	2.09	------	------	3.16	2.18	145
Dwarf kafir	------	4.25	3.27	------	2.82	1.68	------	------	------	3.01	2.32	130
Yellow milo	------	7.35	4.30	------	3.49	1.84	------	------	------	4.25	2.32	183
Dwarf milo	------	5.30	3.27	------	------	2.55	------	------	------	3.71	2.55	145
Feterita	------	3.00	2.43	------	2.62	1.32	------	------	------	2.34	2.32	101
Kaoliang	------	4.10	3.20	------	3.24	------	------	------	------	3.51	2.73	129
Freed sorghum	------	4.03	3.45	------	------	------	------	------	------	3.74	3.27	114
Northwestern Dent corn	------	3.95	2.59	------	1.64	1.10	1.64	------	------	------	2.18	------
Newell, S. Dak.:												
Dakota Amber sorgo	.86	3.23	4.83	1.65	3.85	0	2.95	1.23	2.98	2.40	1.91	126
Corn	.58	2.95	2.29	1.80	2.69	.13	2.41	1.08	3.27	------	1.91	------
Sheridan, Wyo.:												
Dakota Amber sorgo	------	------	------	1.50	2.37	0	2.12	.53	2.79	1.55	1.28	121
Red Amber sorgo	------	------	------	1.27	2.33	0	1.68	.43	4.95	1.78	1.28	139
Corn	------	------	------	1.18	2.51	.13	1.51	.65	1.72	------	1.28	------
Mandan, N. Dak.:												
Dakota Amber sorgo	2.84	1.35	2.44	------	1.65	1.54	1.33	2.43	1.55	1.89	1.88	100
Minnesota Amber sorgo	3.19	.92	2.08	1.61	2.12	2.06	1.48	------	2.67	2.02	1.93	105
Red Amber sorgo	3.52	1.88	3.72	1.55	2.12	2.44	1.02	------	3.35	2.45	1.93	127
Feterita	------	1.09	1.83	.85	------	1.86	------	------	------	1.41	1.90	74
Brown kaoliang	------	1.08	2.21	1.35	1.17	------	.87	------	------	1.34	1.89	71
Northwestern Dent corn	2.11	2.04	2.39	1.88	2.15	1.28	1.00	1.53	2.56	------	1.88	------
Dickinson, N. Dak.:												
Dakota Amber sorgo	------	------	------	------	------	------	1.45	1.32	------	1.39	2.03	68
Corn	1.49	1.67	2.18	.66	1.76	1.04	2.48	1.58	2.45	------	1.70	------
Moccasin, Mont.:												
Dakota Amber sorgo	------	.67	1.43	.77	0	------	0	[2]	1.31	.70	2.57	27
Corn	2.16	3.10	2.21	1.68	3.58	.47	2.78	2.15	2.08	------	2.25	------
Havre, Mont.:												
Dakota Amber sorgo	------	------	------	------	------	------	0	1.77	.80	.86	1.46	59
Red Amber sorgo	------	------	------	------	------	------	0	1.31	.31	.54	1.46	37
Corn	------	------	2.23	.52	.75	.22	1.60	1.43	1.35	------	1.16	------

[1] Interpolated yield. (Six-year average yield of corn : 6-year yield of Dakota Amber : : yield of corn, 1917 : yield of Dakota Amber sorgo, 1917.)
[2] Frosted.

SUMMARY OF VARIETAL EXPERIMENTS.

The results obtained at experiment stations and the experience of farmers indicate that the sorgos (sweet sorghums) are superior to the grain sorghums whenever forage alone is desired. In hay, fodder, and silage yields, well-adapted varieties of sorgo have excelled the best varieties of grain sorghum in every part of the Great Plains

and in other sections where sorghums are grown. Sorgo hay and fodder are generally acknowledged to be of better quality or at least more palatable than the hay and fodder of grain sorghums, and recent feeding tests have shown that there is but little difference in the feeding value of the silages. None of the sorghums are reliable grain producers in the Northern Great Plains. For forage, corn, millet, and the small grains are preferable to sorghum in North Dakota and Montana, but the early varieties of sorgo make higher yields of fodder than the above crops in South Dakota and yield equally as high in northeastern Wyoming.

SWEET-SORGHUM VARIETIES

The Dakota Amber, an early dwarf strain of Black Amber developed by A. C. Dillman (*5*), is the best variety discovered so far for North Dakota and Montana. It needs only 85 to 90 days to mature

FIG. 12.—Dakota Amber sorgo at Hays, Kans., in 1919. Seeded May 29. Photographed August 27.

and is a sure seed producer (fig. 12). In South Dakota and northern Nebraska Red Amber makes larger yields of fodder than Dakota Amber, but does not regularly produce germinable seed. The choice between these two varieties in this section, therefore, will depend on whether the farmer is willing to buy his seed for sowing purposes.

Red Amber requires 90 to 100 days for maturity and is better suited to conditions a little farther south in Nebraska and northern Kansas. It has a good performance record at Hays, Kans., and was recommended at one time (*7*) as the best variety for western Kansas. In the last few years, however, Red Amber has shown marked susceptibility to head smut and a slight tendency to lodge when the growth is heavy; because of these weaknesses the variety is losing favor.

Black Amber (F. C. I. No. 7038) is a leafy early-maturing strain developed by selection at Hays, Kans. (Fig. 13.) In length of

growing season it is intermediate between Dakota Amber and Red Amber, requiring an average of 90 days for maturity. This variety and Red Amber are the most reliable forage crops for southwestern Nebraska and northeastern Colorado.

The Leoti Red is a sorgo variety brought to the vicinity of Leoti, Kans., about 25 years ago from Muncie, Ind. It is from three to eight days later than Red Amber, according to the tests at Hays, Kans., very uniform in growth, and a good seed producer. (Fig. 14.) Leoti Red yields about the same as Red Amber, has less head smut, stands up well until ripe, makes a good quality of fodder, and is a promising variety for western Kansas and southeastern Colorado.

Orange sorgo is one of the older and well-known varieties which is still being grown extensively. It is of most value, however, in eastern

FIG. 13.—A leafy strain of Minnesota or Black Amber sorgo at Hays, Kans., in 1919. Seeded May 29. Photographed August 27.

Kansas and Oklahoma and the more humid region east of the sorghum belt. A variety known as the Kansas Orange [10] has been under test at Hays, but it requires 110 to 115 days for maturity and is therefore not adapted to points so far west. It is one of the best silage varieties for eastern Kansas. A strain of Orange known to be representative of the variety has been under test at Chillicothe, but was found less productive than Sumac.

The Sourless, a sorgo variety known in some localities as White Orange, resembles the Orange very closely except for its yellowish white seeds. It is most popular in southwestern Kansas and is grown very little elsewhere. Its forage yields at Hays, Kans., have been very good, and the variety appears worthy of more consideration.

[10] This variety resembles Planter sorgo and is probably only a selected strain of that variety.

Sumac sorgo is the leading variety of sweet sorghum throughout Oklahoma and Texas. It is too late for Kansas, requiring approximately 124 days to mature at Chillicothe, Tex. Tests at all the Oklahoma and Texas field stations have uniformly placed Sumac among the highest yielding sorghum varieties. Other good features of Sumac are its uniformity of growth and its leafiness, besides which it seldom fails to produce seed except in the Panhandle districts of the above-named States. (Fig. 15.)

Early Sumac (F. C. I. No. 02552) is an early strain of Sumac developed at Hays, Kans. It ordinarily matures in 100 days and produces good yields of forage and seed. Early Sumac is leafy and is a first-class forage variety except for a slight tendency to lodge.

FIG. 14.—Leoti Red sorgo at Hays, Kans., in 1922. Seeded May 20. Photographed August 31.

Honey sorgo, also called "Japanese cane" and "Japanese seeded ribbon cane," is perhaps of most importance as a sirup variety. It is leafy, very juicy, and sweet; producing good, palatable forage and a better quality of sirup than Sumac under climatic conditions where it will mature. At many of the field stations in Oklahoma and Texas, Honey made larger yields of forage than Sumac, but it rarely matured seed. The average growing season for Honey was 137 days at Chillicothe, Tex. This variety is best adapted to eastern Texas, southeastern Oklahoma, and the States east of this district, in which territory it is deserving of more extended use. If good, pure seed of Honey could be obtained regularly, a much larger acreage of it would be grown.

White African sorgo is a variety but little known, yet possessing considerable promise. The stems are coarse and not so leafy as are those of Sumac, resembling the Orange more in this respect. White African matures in 122 days at Chillicothe, Tex., and may prove

valuable as a silage producer in eastern Kansas, Oklahoma, and Texas. The seed being white should be nearly equal to the seed of grain sorghums in feeding value, but it is at a marked disadvantage commercially, because a large percentage of the glumes remain on the seed after it is threshed.

Gooseneck sorgo, often sold by seedsmen under the name of "Texas seeded ribbon cane," requires the longest season for maturity and produces the highest forage yields of any of the commercial sorgo varieties. The fodder is extremely coarse and difficult to handle, however, and there are many seasons in which it does not mature seed, even as far south as Chillicothe, Tex. In some localities it is highly esteemed as a silage variety.

FIG. 15.—Sumac sorgo at Chillicothe, Tex., in 1922. Seeded May 19. Photographed August 23. Note the uniformity which has been attained with this variety by continued selection.

GRAIN-SORGHUM VARIETIES.

Many farmers prefer a variety of sorghum producing both grain and fodder of good quality, in which the kafirs are supreme. The earlier varieties of kafir can be grown successfully from Hays, Kans., southward. North of Hays grain-producing sorghums are of little importance.

The quality of kafir forage is better than that of milo or feterita, and for this reason many farmers persist in growing kafir even though they obtain larger grain yields from milo and feterita. It is often asserted that well-cured kafir fodder is as palatable to livestock as the fodder made from sorgos and equal in feeding value.

Pink kafir, a variety very largely developed at the Hays experiment station, is perhaps the best for that locality for both forage and grain (fig. 7), although dwarf strains of Blackhull are strong competitors of the Pink. This kafir will mature in approximately

110 days: and the better strains of it are dependable grain producers. Its field of greatest usefulness is in west-central Kansas. Pink kafir requires too long a growing season for the extreme western part of Kansas, and in the eastern and southern parts of the State Blackhull kafir ordinarily outyields it except on the poorer soils, where Pink is more likely to mature a grain crop than Blackhull.

Blackhull kafir, or Standard Blackhull, as it is often called, is the best-known grain-sorghum variety. It requires approximately 120 days to mature and therefore is at home only in the eastern part of the sorghum belt, where the rainfall is more abundant and the growing season longer. Blackhull kafir can not compete with the earlier maturing Pink and Dwarf Blackhull kafirs west of the ninety-eighth meridian. East of this line it will no doubt continue to be the leading kafir variety. The Blackhull kafir which is now being

FIG. 16.—A field of Dwarf kafir at Lawton, Okla.

grown in this region is not, however, so tall as it was formerly, because farmers appreciate the greater ease of harvesting a crop where the stalks are 6 feet or less in height.

Dwarf kafir and Dwarf Blackhull kafir are names applied to small early-maturing strains of Blackhull. Under the climatic conditions existing in the southern Great Plains Dwarf kafir matures in 105 to 110 days at a height of 44 to 50 inches. Its short growing season permits its successful production at higher altitudes and in regions of lower rainfall than the Blackhull or Pink kafirs. (Fig. 16.) Dawn kafir is a strain of Dwarf kafir developed by C. R. Ball, of the Office of Cereal Investigations, at the field station at Amarillo, Tex., and is the leading variety of Dwarf kafir.

Sunrise kafir is an early sweet-stemmed strain of Blackhull selected by C. R. Ball from the same hybrid parent that produced Dawn

kafir. It matures in practically the same time as Dwarf kafir, but grows as tall as Standard Blackhull. The sweet, juicy stems give increased palatability to the fodder, and on this account it has a limited field of usefulness. It is appreciated most in northwestern Oklahoma. The fact that other varieties of kafir make higher grain yields will prevent a very extensive production of Sunrise.

Red kafir has been grown throughout the sorghum belt almost as long but not so extensively as Blackhull. Many farmers claim that Red kafir is earlier and more drought resistant than Blackhull, but experiments have not supported this theory. It is adapted to the same district as Blackhull and will make about the same yields of both fodder and grain. (Fig. 17.) The fact that grain markets prefer a white-seeded kafir has no doubt helped to limit its production.

FIG. 17.—Blackhull kafir (left) and Red kafir (right) at Chillicothe, Tex., in 1922. Seeded May 19. Photographed August 23.

Dwarf hegari, a variety of sorghum more or less intermediate in character between Blackhull kafir and feterita, has been most successfully grown in the irrigated districts of the Southwest, particularly in the Salt River Valley of Arizona. The forage would rank with that of the kafirs in quality were it not for a tendency of the variety to produce many coarse tall hybrids of unknown origin. The grain is of excellent quality, but its production is most uncertain under droughty conditions. It has often made good yields of forage and grain in the sorghum belt, but is so extremely variable in its habit of growth and its maturity that further work in stabilizing it will have to be done before it can be recommended for general use. There seem to be in this variety good possibilities for selection.

When forage is a secondary consideration and an assured grain crop is desired, the milos and feterita are preferable to the kafirs under the more adverse conditions in the western part of the sorghum belt.

Dwarf milo is by far the best variety of this group and makes up a large proportion of the grain-sorghum acreage in western Kansas, Oklahoma, and Texas and in eastern Colorado and New Mexico. It matured in 103 days at Chillicothe, Tex., 105 days at Hays, Kans., and 113 days at Amarillo, Tex. The longer season at Amarillo was largely the result of summer droughts. The yields of forage and grain have been consistently good. (Fig. 18.) Dwarf milo is preferred to feterita by farmers because it is easier to obtain a good stand of the milo, it does not lodge so frequently, matures more uniformly, and the seed shatters less.

Early White milo has made the largest grain yields at Hays, Kans., but is of little value from a forage standpoint. Excepting Freed

FIG. 18.—Dwarf milo at Hays, Kans., in 1920. Seeded June 2. Photographed September 13.

sorghum, this variety is the earliest of all the grain sorghums, maturing in 90 days at Hays. Early White milo has slender pithy stems and few leaves and lodges rather easily. It will no doubt be grown very little except under the most severe conditions.

Dwarf White milo is a companion variety to the Dwarf milo (yellow) and very similar to the latter variety except for its white seeds. It matures at practically the same time and seems adapted to the same conditions. This variety is a late acquisition and may be improved by selection. At present it yields less than the Yellow milo.

Feterita has made a good record under experimental conditions, especially at Hays, Kans., and Chillicothe, Tex. (See figs. 8 and 9.) This record was due in part, at least, to the care used in the preparation of the seed bed and the uniformly late date of seeding. Good

stands resulted from the care in seeding, and loss from shattering was avoided by harvesting the crop as soon as it was ripe. A good stand of feterita is rarely obtained under ordinary farm conditions, and the yields are reduced by allowing the crop to stand in the field after it is ripe. This perhaps accounts in a measure for the decrease which has taken place in the relative acreage of feterita throughout the sorghum belt. In Kansas in 1915 feterita occupied 265,322 acres, or about 17 per cent of the total grain-sorghum acreage of that State; in 1919 there were only 77,134 acres of feterita, or 7 per cent of the total. The present acreage of feterita in Texas has been estimated at 10 per cent, and in Oklahoma, New Mexico, and California at 5 per cent or less of the grain-sorghum acreage in these States. This decrease in acreage may be only partly due to the aforementioned weaknesses of feterita. It is of most value in dry years, and the past eight years have been rather favorable for the sorghums.

FIG. 19.—Freed sorghum at Hays, Kans., in 1916, showing its extreme earliness and value in regions subject to drought. Photographed August 14. The sorghum on the right was seeded on May 3 and is ready to harvest; that on the left was seeded July 1 and had neither rain nor cultivation after seeding, yet headed quite well.

Spur feterita, an improved forage variety originated by the Texas Agricultural Experiment Station at Spur, Tex., has more leaves and a stouter stem than the ordinary feterita and matures about one week later (*4*). Spur feterita has done well at Hays, Kans., and Chillicothe, Tex. (see fig. 12), and would probably replace the ordinary variety of feterita to a large extent if it were not for the fact that feterita is grown principally because of its earliness.

Several varieties, which are not easily grouped because of their hybrid origin, deserve passing mention. Freed sorghum is a small and extremely early variety with white seeds, which if they threshed free from the glumes would no doubt equal kafir seed in feeding value. Seeded on July 1 Freed headed fully in 45 days at Hays, Kans., in 1916, without either rain or tillage during this period. (Fig. 19.)

Although the yield of forage is small and of rather poor quality, the variety may be used to good advantage for late seeding when other crops have failed or when for any reason the farmer finds himself as late as July 15 in danger of a feed shortage. A few farmers have used Freed advantageously in mixture with Sudan grass and sorgo as a hay crop. Freed sorghum improves the quality of the hay by the added quantity of grain which it supplies.

Darso sorghum is a new variety developed and named by the Oklahoma Agricultural Experiment Station (*1*). It is early, dwarf, leafy, and sweet stemmed, with large, rather loose but erect heads. Darso produced 14 per cent less forage but 11 per cent more grain than Dwarf kafir at Chillicothe, Tex. (Fig. 20.) At all other field stations in the southern plains it has compared favorably in yields with the other varieties of grain sorghums. Darso is a reliable grain producer south of Kansas, particularly in adverse seasons. The

FIG. 20.—Darso sorghum (left) and Dwarf kafir (right) at Chillicothe, Tex., in 1922. Seeded May 19. Photographed August 23.

characteristic that interferes more than anything else in its becoming generally popular pertains to the feeding value of the seed, which resembles that of the sorgos. Feeding tests at the Oklahoma station indicated that the seed of Darso had a slightly lower feeding value than that of kafir when measured by gains in flesh. Recent palatability tests at the Kansas Agricultural Experiment Station indicate that with hogs Darso seed ranks as about equal to sorgo seed in palatability. For forage alone Darso can not compete with the sorgos, because the yields are much less than those of Sumac and Orange.

Schrock sorghum has attained more or less prominence, but tests have proved that it has no special merit either as a grain or forage variety. Compared with the standard varieties, it did best at Tucumcari, N. Mex., but there it is exceeded in forage value by Sumac sorgo and in grain yields by Dwarf hegari and Darso. Schrock made

a good grain yield at Woodward, Okla., but the seeds resemble those of sorgo and have a low feeding value.

The remaining varieties that were included in the tests are not discussed in detail because they appear to be of only minor importance.

CULTURAL EXPERIMENTS.

The cultural experiments here discussed relate to the date of seeding and rate of seeding. These tests were conducted only in the sorghum belt and included from two to five of the leading varieties in each locality. The most extensive work was with the date of seeding, on which subject data are reported from eight stations. Data on rate of seeding, both in rows and in close drills, are reported from three stations, Hays, Kans., and Chillicothe and Amarillo, Tex. Under "Time of cutting" the results obtained with close-drilled Red Amber sorgo at Hays, Kans., are presented.

Cultural data were not obtained in so extensive a manner as the varietal comparisons already recorded, but the general principles developed by these experiments are, with slight modifications, applicable to most of the sorghum belt.

DATE OF SEEDING.

In these experiments from two to five of the leading varieties in each locality were seeded at approximately 2-week intervals throughout the available planting season, as near the first and middle of the month as possible. In the choice of varieties attention was given to relative earliness as well as the local importance. With this factor in mind Sumac was selected as a medium to late and Red Amber as an early sorgo for the stations south of Hays, Kans. Among the grain sorghums [11] some strain of kafir was selected as a medium to late variety, milo and feterita as medium early, and Freed as very early.

At Hays, Kans., there were five dates of seeding, May 1 to July 1; at Chillicothe, Tex., seven dates, from April 1 to July 1; at Dalhart, Tex., four dates, May 1 to June 15; and at the other five stations six dates, from April 15 to July 1. The sorghum in these experiments was all grown in cultivated rows 40 to 44 inches apart and usually surface planted.

In the matter of soil preparation and tillage after seeding, it is important to note that the best rather than the average farm practice was usually followed. The customary plan was to set aside in early spring, prior to the first date of seeding, a field large enough to include all of the date-of-seeding experiments. This field was kept clean and in good tilth until seeding time, a practice favorable to the late seedings as compared with the common farm practice of seeding with little or no prior soil preparation.

The earliest seedings also were given better care than is usually accorded to sorghum on the farm. Under average farm conditions seeding in April, or even on May 1, often gives much less favorable results, owing to poor stands and weed competition during the sorghum's slow early growth. In the experimental work these factors were overcome or their effect minimized by sowing plenty of

[11] Experiments with the grain sorghums are reported only from Hays, Kans., and Chillicothe and Amarillo, Tex.

high-germinating seed on land which had received fall or early spring seed-bed preparation, by surface planting instead of listing, and by sufficiently thorough cultivation after planting to prevent weed injury to the crop.

EXPERIMENTS AT HAYS, KANS.

The date-of-seeding experiments at Hays, Kans., were conducted with five varieties from 1914 to 1918, inclusive. This period included two relatively favorable seasons, 1914 and 1915, and three others that were droughty at times, but conditions were never so severe as those experienced at Hays in 1911 and 1913. The experiments were continued uniformly from year to year, not seriously interrupted by any such extremes of drought, soil blowing, excessive rain, or insect damage as occurred at some of the southern stations.

Duplicate twentieth-acre plats were used in the experiments. The rows were 40 inches apart, planted in lister furrows in 1914, 1917, and 1918, and surface-planted on fall-plowed ground in 1915 and 1916. The preceding crop in 1914 was spring grain, in 1915 Sudan grass, and in 1917 and 1918 winter wheat.

The first date of seeding at Hays varied from May 1 to 5, which is about the average date of the last killing frost in spring. At this time the ground was generally in a fair state of tilth and moisture, but too cold for prompt germination of the seed. Generally there was a cold wet spell of 10 days or more in May after the first date, and often after the second date of seeding.

The average time required for both May 1 and May 15 seedings to emerge was 14 days, as compared with 7 days for the June 1 and June 15 and 5 days for the July 1 seeding. Fairly good stands were usually obtained regardless of the date of seeding, since choice seed was always used and seeded very thick whenever conditions seemed unfavorable for germination. This practice made it necessary in a few cases to thin the stand. The earlier the seeding, the more trouble there is from weeds. It was sometimes necessary to hoe the weeds out of the May 1 and May 15 plats. From a weed-control standpoint later seeding was the more satisfactory, because it is easier to kill weeds before seeding than after.

The results of seeding sorghum on different dates at Hays, Kans., are shown in Table 14.

There is much less variation in the yields obtained from sorghum sown on different dates than ordinarily would be expected. In fact, they show that with proper care the sorghums may be seeded for forage purposes over a wide range of time. The best date for seeding, however, is between May 15 and June 15. For grain, the indications are more definite. The best yields of Dawn kafir were obtained from May 15 and June 1 seedings, suggesting that it should be seeded about as early as conditions are favorable. The superiority of the June 1 date for feterita and the June 15 date for Freed are very marked, indicating that these varieties are suitable for late seeding. Freed matured fully each year in the plat seeded on July 1.

It was noted that all varieties seeded on May 1 matured only 5 to 8 days earlier in the fall than that sown May 15 and but 12 to 15 days earlier than the June 1 seedings.

In actual farm practice at Hays it is found best to begin seeding the varieties having long seasons about May 10 to 15 and to try to finish with the short-season varieties as early in June as possible.

TABLE 14.—*Agronomic data regarding sorghum varieties grown in date-of-seeding experiments at Hays, Kans., in the 5-year period from 1914 to 1918, inclusive.*

Variety and approximate date of seeding.	Yields per acre.										Average.		Average.	
	1914		1915		1916		1917		1918		Average.			
	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	Height.	Season.
Black Amber:	*Tons.*	*Bush.*	*Tons.*	*Bush.*	*Tons.*	*Bush.*	*Tons.*	*Bush.*	*Tons.*	*Bush.*	*Tons.*	*Bush.*	*Inches.*	*Days.*
May 1	2.31	27.2	4.07	40.9	2.21	15.4	1.62	9.6	2.20	7.1	2.48	20.0	67	114
May 15	2.51	28.8	3.59	35.1	1.83	7.0	1.76	9.8	2.65	3.6	2.47	16.9	65	107
June 1	2.33	26.3	4.22	37.6	1.86	6.8	1.65	11.8	2.78	7.3	2.57	18.0	67	95
June 15	2.45	31.9	4.73	40.8	2.35	12.5	1.81	10.9	2.47	9.5	2.76	21.1	71	90
July 1	2.46	30.0	4.44	32.1	1.89	7.7	2.05	15.7	2.29	0	2.63	17.1	68	88
Red Amber:														
May 1	2.87	11.7	4.76	29.6	1.12	0	2.00	10.9	2.24	4.3	2.60	11.3	70	121
May 15	2.93	15.4	4.32	20.5	1.26	0	1.86	10.2	1.91	0	2.46	9.2	65	111
June 1	3.81	19.3	4.82	16.6	1.81	0	2.34	11.1	2.07	0	2.97	9.4	66	101
June 15	3.48	15.9	5.50	25.8	1.86	0	2.60	10.5	1.73	3.6	3.03	11.2	68	95
July 1	3.64	23.9	4.54	9.5	1.70	0	2.87	5.2	1.95	0	2.94	7.7	65	95
Freed sorghum:														
May 1	2.30	28.5	3.06	27.3	1.14	12.4	.99	6.3	.45	4.1	1.59	15.7	69	115
May 15	2.34	25.4	2.95	23.1	1.01	9.6	1.35	5.2	1.42	15.2	1.81	15.7	67	106
June 1	2.22	26.5	3.43	22.3	1.21	11.6	1.44	7.3	1.57	13.9	1.97	16.3	68	94
June 15	2.46	31.5	3.83	26.4	1.54	14.5	.93	7.0	1.80	10.7	2.11	18.0	67	88
July 1	2.43	27.4	3.39	20.9	1.37	14.3	1.15	6.4	1.92	9.8	2.05	15.8	66	83
Feterita:														
May 1	1.75	16.8	3.94	29.6	1.36	9.8	1.30	8.6	.70	6.3	1.81	14.2	60	119
May 15	2.24	18.3	3.21	32.5	1.03	7.3	1.66	12.7	1.55	8.8	1.94	15.9	56	110
June 1	3.18	28.1	4.26	42.6	1.15	3.6	1.27	10.4	1.70	6.8	2.31	18.3	54	101
June 15	2.44	19.4	2.48	19.7	.87	5.9	1.60	11.8	1.79	8.9	1.84	13.1	54	94
July 1	2.86	21.3	2.78	12.9	.98	3.9	1.52	5.0	1.77	0	1.98	8.6	53	97
Dawn kafir:														
May 1	3.08	7.2	4.35	29.1	.90	4.3	2.14	1.8	.22	3.0	2.14	9.1	50	129
May 15	3.55	9.0	5.09	62.9	1.02	3.2	2.44	1.8	.76	5.9	2.57	16.6	50	120
June 1	3.29	7.4	6.10	65.1	.99	1.3	2.39	0	1.62	10.2	2.88	16.8	49	111
June 15	3.55	19.3	4.46	42.7	1.29	0	2.43	0	1.70	8.4	2.69	14.1	48	108
July 1	2.38	0	4.41	9.6	1.69	0	2.78	0	1.77	0	2.61	1.9	46	------

EXPERIMENTS AT CHILLICOTHE, TEX.

The experiments at Chillicothe began a month earlier each year than at Hays and encountered a greater variation of climatic factors. Five varieties were grown on duplicate twentieth-acre plats throughout the period from 1913 to 1917. The preceding crop in 1913 and 1914 was sorghum, and from 1915 to 1917 it was small grain. The soil preparation consisted of plowing in the fall or winter, working the ground down in the spring, and seeding in shallow furrows.

The first two dates, April 1 and 15, rarely afforded ideal seeding conditions, the soil in most years being too cold and damp and in 1917 too dry. Weeds were much more troublesome in these early seedings, and in several instances the stands were quite irregular, especially those of feterita and Freed sorghum. The April 1 seedings required from 10 to 31 days to emerge; the April 15 seedings, 7 to 23 days; and the later dates with few exceptions only 4 to 7 days. The dates from May 1 to June 15, inclusive, were all quite satisfactory in general, except that long wet periods in 1914 and 1915 prevented seedings on those dates. July 1 was too dry for seeding in 1913, and in 1916 only the Freed came up promptly.

In 1914 two cuttings, both of which matured seed, were obtained from the seedings of feterita made on April 1 and April 15. A second cutting, of forage only, was obtained from the third date of feterita, the first four dates of Freed, the first two dates of kafir and milo, and

the first date of Sumac. In 1915 a fair second growth was made on the April 1 and April 15 plats of Freed, feterita, and milo, but this second crop was not harvested because the sorghum midge prevented the formation of seed. The midge was also responsible that year for the failure of the seed crop on the June 1 and later seedings of Sumac, the June 15 and July 1 seedings of kafir, milo, and Freed, and the July 1 seeding of feterita. In the other years of the experiments and in subsequent years there has often been a drought after the earliest plats were mature but in time to reduce the grain yields of later varieties to some extent.

The experiments for which yields are given in detail cover only the five years, 1913 to 1917, inclusive, but in considering the results reference is made to some interesting preliminary experiments with kafir and milo conducted during 1907, 1908, and 1909. Data for 1913 to 1917, inclusive, as given in Table 15 show the effect of seeding at different dates on the yields of forage and grain, the average height of the plants, and the length of time required by the variety to mature.

TABLE 15.—*Agronomic data regarding sorghum varieties grown in date-of-seeding experiments at Chillicothe, Tex., in the 5-year period from 1913 to 1917, inclusive.*

[Yields marked with a star (*) are interpolated, seeding being prevented by weather conditions.]

Variety and approximate date of seeding.	Yields per acre.												Average.	
	1913		1914		1915		1916		1917		Average.			
	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	Height.	Season.
	Tons.	*Bush.*	*Tons.*	*Bush.*	*Tons.*	*Bush.*	*Tons.*	*Bush.*	*Tons.*	*Bush.*	*Tons.*	*Bush.*	*Inches.*	*Days.*
Sumac:														
April 1	2.18	0	8.63	7.3	4.53	18.2	2.16	0	1.94	1.3	3.89	5.4	65	164
April 15	1.55	0	5.90	33.6	6.18	17.9	2.30	0	2.02	1.9	3.59	10.7	69	163
May 1	.95	0	7.95	35.4	6.78	19.6	2.81	0	2.26	1.9	4.15	11.4	71	150
May 15	.72	0	*7.61	*31.3	6.15	19.6	3.47	0	3.09	2.6	4.21	10.7	68	139
June 1	2.89	0	*8.90	*36.9	8.18	0	3.93	0	2.39	2.8	5.26	7.9	65	130
June 15	1.55	0	7.55	20.0	9.68	0	3.42	0	1.87	3.4	4.81	4.7	72	122
July 1	*1.23	0	7.70	32.5	8.63	0	0	0	2.73	5.9	4.06	7.7	83	108
Freed sorghum:														
April 1	.63	3.2	2.48	11.3	.95	13.9	.84	9.1	.43	3.4	1.07	8.2	56	116
April 15	.80	6.1	2.73	15.5	1.43	21.4	1.00	12.1	.78	5.0	1.35	12.0	57	104
May 1	.82	6.3	4.05	18.4	1.98	26.8	1.30	17.0	.85	7.1	1.80	15.1	58	93
May 15	.85	5.0	*3.82	*26.9	2.25	30.5	1.18	15.0	.75	5.5	1.77	16.6	56	89
June 1	1.00	5.0	*4.93	*24.7	3.00	25.7	1.52	15.6	1.13	12.4	2.32	16.7	60	80
June 15	.90	1.6	3.58	11.3	2.33	0	1.39	10.8	.84	10.1	1.81	6.8	62	74
July 1	*.67	0	1.88	14.8	2.75	0	.82	5.4	1.02	5.6	1.43	5.2	64	83
Feterita:														
April 1	1.08	14.8	3.73	35.9	1.23	11.4	.97	13.5	1.18	10.2	1.64	17.2	57	123
April 15	1.09	12.7	5.09	44.8	1.68	14.3	1.23	17.3	.57	3.2	1.93	18.5	55	113
May 1	1.27	13.6	5.03	20.0	2.28	29.3	1.38	18.8	.82	7.4	2.16	17.8	52	100
May 15	1.28	3.9	*5.11	*33.3	3.30	33.6	1.18	15.2	.72	7.9	2.32	18.8	51	93
June 1	1.24	0	*5.48	*33.3	3.28	30.4	1.65	22.3	.90	8.3	2.51	18.9	52	93
June 15	1.64	0	3.65	26.6	4.44	37.0	1.46	19.5	1.44	12.4	2.53	19.1	57	99
July 1	*1.06	0	4.30	48.4	3.00	0	0	0	1.63	11.3	2.00	11.9	64	92
Dwarf Yellow milo:														
April 1	.93	10.9	4.18	28.2	1.18	17.1	1.14	16.5	.40	1.8	1.57	14.9	38	126
April 15	1.22	11.6	3.53	17.7	1.45	19.8	.98	12.7	.59	2.8	1.55	12.9	39	113
May 1	1.00	8.4	5.45	35.7	2.33	19.8	1.24	11.6	.51	0.8	2.11	15.3	40	116
May 15	1.05	1.6	*5.59	*37.7	3.65	28.4	1.12	7.6	1.03	6.6	2.49	16.4	40	103
June 1	1.02	0	*6.00	*29.3	3.88	39.3	1.34	0	1.44	6.7	2.74	15.1	42	108
June 15	1.55	0	5.45	47.0	5.23	0	1.09	0	1.41	3.7	2.95	10.1	45	109
July 1	*1.13	0	5.55	55.0	3.58	0	0	0	1.61	7.3	2.37	12.5	53	99
Blackhull kafir:														
April 1	1.66	0	4.63	16.1	2.70	32.1	1.61	6.3	1.71	8.7	2.46	12.6	49	142
April 15	1.88	0	3.30	14.8	3.23	38.0	1.65	3.4	1.74	6.2	2.36	12.5	47	137
May 1	1.89	0	5.28	47.1	2.38	25.9	1.79	0	1.56	4.5	2.58	15.5	51	137
May 15	1.90	0	*5.26	*47.0	4.28	39.8	1.95	0	1.31	0.9	2.94	17.5	49	128
June 1	2.16	0	*5.45	*56.8	*3.99	*37.2	2.28	0	2.27	8.4	3.23	20.5	44	123
June 15	2.57	0	5.33	55.5	4.83	0	2.48	0	1.06	4.7	3.25	12.0	57	122
July 1	*2.10	0	6.07	47.9	4.83	0	0	0	1.89	7.1	2.98	11.0	66	112

Throughout these experiments it will be noted that the highest forage yields were obtained from the June 1 and June 15 seedings. The quality of the fodder was also considered superior to that produced by seeding at an earlier date, because being harvested later it did not dry out so much before the winter feeding period. The data on seed production are less consistent and conclusive; but the best general results, excepting only feterita, were obtained by seeding about two weeks earlier than the optimum dates for forage.

In preliminary tests with three varieties of kafir and with Dwarf Yellow milo during the period from 1907 to 1909, April 15 and May 1 were the best dates for grain production, sometimes outyielding by more than 100 per cent the May 15 and June 1 dates. In 1907 the Blackhull kafir yields varied rather uniformly from 37 bushels on the April 15 date down to 5 bushels from the July 1 seeding. For Red kafir the yields varied in the same way, from 34 bushels to 10 bushels per acre. The milo yields in 1907 were not as uniform as those of the kafirs; the May 1 date ranked first, April 15 second, and June 15 third. In 1908 the kafir yields were irregular, but showed best results from April 27 to May 15, with yields from 15 to 33 bushels. On June 1 kafir yields varied from 15 to 18 bushels, and all seedings made after June 1 failed to produce grain. Milo in 1908 yielded 22.5, 27.9, 25.9, and 30.2 bushels per acre from the April 27, May 1, May 15, and June 1 seedings, respectively, and as in the case of kafir failed entirely on later dates. In 1909 there was no effective rainfall in July, August, and September, and the kafir varieties produced no grain yields on any of the dates. Milo in 1909 produced 14.8, 12.7, and 6.4 bushels per acre from April 15, May 1, and May 15 seedings, respectively, followed by failures on the later dates.

A survey of the forage yields in 1907 and 1908 shows them highest on the June 1 and June 15 dates for both kafir and milo; the difference, however, between the early and late seedings was slight. In 1909 the early seedings gave markedly higher yields than the late ones, due to the low rainfall in the latter part of the season. The value of the forage was perhaps greater for the early dates in 1907 and 1908, owing to the larger quantity of grain it contained.

The grain yields obtained in the date-of-seeding experiments from 1913 to 1917 did not confirm the superiority of the early dates. Grain yields were highest for all the grain sorghums in seedings made from May 1 to June 1, owing in part at least to the intensive culture given the late-seeded plats from early spring until the time for seeding arrived.

EXPERIMENTS AT AMARILLO, TEX.

The experiments to determine the best date for seeding sorghums at Amarillo were conducted during the same years as at Chillicothe, Tex., but do not include the same varieties. Kafir and milo were omitted from the tests at Amarillo, in order not to duplicate work being done there with these varieties by the Office of Cereal Investigations (*10*). Results with Freed sorghum during the first three years were so disappointing on account of bird damage that Clubhead, a promising early sorgo, was substituted for it in 1916 and 1917.

As the entire season of 1913 was so adverse on account of drought and as the plats, although triplicated, were only 8-rod rows on which stands were made irregular by ground squirrels, the results offer but

little, if any, basis for a decision as to the best date of seeding. Late rains in September benefited the three latest seedings of Sumac. Feterita and Freed headed and made some seed on all dates; but birds took most of it, especially that of Freed, in the milk stage. Sumac made no heads.

The comparatively low yields obtained throughout the five years of the experiments were due partly to the fact that, except in 1913, when the plats were on fallow, they followed Sudan grass or sorghum and therefore had no reserve supply of moisture to supplement a rather irregular seasonal precipitation.

In 1914 the tests were quadruplicated in 8-rod rows. The April 15 and May 1 seedings did not come up till May 21, but the other seedings emerged in one to two weeks from the date of sowing. Stands were rather thin and quite irregular except with Sumac, which averaged from 4 to 8 inches row space per plant on the different dates and was possibly a little too thick for the season.

In 1915, 1916, and 1917 the experiments were conducted on duplicate 4-row plats of a twenty-fifth of an acre each. In 1915 the experiments were extended to eight dates, April 1 to July 15. This in general was a year of abundant moisture, the season opening in April with 5.05 inches of precipitation distributed over 15 days. The early seedings, as usual, germinated very poorly and slowly. The April 2 seedings were up on May 1, and the later seedings in one to two weeks, except those of July 1, which came up July 21 along with the July 15 seeding. There was no frost until November 12, so that the late dates of seedings were able to make good use of the well-distributed rainfall of nearly 15 inches during July, August, and September. The July 15 seeding of feterita reached the hard-dough stage and yielded 13.6 bushels per acre. Freed and Red Amber in the July 1 seeding matured well, but Sumac seedings made later than June 1 did not mature. The extremely high tonnage of Sumac from the later seedings is in part due to yields being reported on a field-cured basis, so that the later the harvesting the less fully the fodder was cured.

The season of 1916 was especially adverse in the matter of getting stands. The rainfall was not only low but was distributed in many small ineffective showers. The only really effective rains up to August 20 consisted of 0.97 inch on April 14, 0.88 inch on May 17, and 1.38 inches on June 4. Several seedings were much delayed in coming up, and except in the Sumac plats stands were quite irregular. One replication was injured considerably by volunteer sorghum, especially in the earlier seedings. Feterita headed fairly well throughout the test, but birds took most of the seed from the earlier plats. Hail damage was a factor of some importance on seedings made on June 1 or later. Considering quality and maturity as well as yield, Red Amber and Clubhead probably did best on the June 15 seeding. Sumac made the largest yields of forage on the May 15 and June 1 seedings, but produced no heads from the sowing on any date except at the ends of the rows.

In 1917 less trouble was experienced in getting stands than in the preceding years. The stands were fairly uniform on all dates, though a snow on May 6 killed some of the April 15 seedings as they were emerging. A protracted midsummer drought held all growth stationary for several weeks until broken by 6 inches of rain in

August. This rain, though helpful, was not so effective as might be expected. Drought conditions returned in the fall, checking growth so that some plats were still immature on October 20 when the first frost occurred.

The results obtained from the date-of-seeding experiments at Amarillo, Tex., are given in Table 16. These data are rather irregular on account of the unfavorable growing conditions prevailing several years during the period.

TABLE 16.—*Agronomic data regarding sorghum varieties grown in date-of-seeding experiments at Amarillo, Tex., in the 5-year period from 1913 to 1917, inclusive.*

Variety and approximate date of seeding.	Yields per acre.												Average.	
	1913		1914		1915		1916		1917		Average.			
	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	Height.	Season.
	Tons.	*Bush.*	*Tons.*	*Bush.*	*Tons.*	*Bush.*	*Tons.*	*Bush.*	*Tons.*	*Bush.*	*Tons.*	*Bush.*	*Inches.*	*Days.*
Sumac:														
April 15	0.64	0	3.45	0	9.14	37.9	3.26	0	4.44	0	4.19	7.6	57	159
May 1	.88	0	3.10	0	8.51	23.7	3.03	0	4.74	0	4.05	4.7	56	147
May 15	.57	0	3.05	0	8.76	36.8	4.46	0	3.88	0	4.14	7.4	60	136
June 1	1.25	0	3.65	0	9.71	35.1	4.34	0	2.96	0	4.38	7.0	60	134
June 15	1.45	0	3.10	0	12.13	0	3.51	0	3.40	0	4.72	0	56	124
July 1	1.35	0	1.85	0	11.88	0	.24	0	3.63	0	3.79	0	57	115
Red Amber:														
April 15			2.75	17.7	1.66	22.1	1.06	0	2.15	20.1	1.91	15.0	60	131
May 1			2.55	10.7	2.44	29.5	1.54	0	2.38	14.3	2.23	13.6	58	122
May 15			2.05	9.2	1.80	16.5	1.96	0	3.88	0	2.42	6.4	62	120
June 1			2.20	11.1	4.44	49.6	1.63	2.2	2.11	16.3	2.60	19.8	62	109
June 15			2.15	9.6	5.03	48.0	1.54	10.5	3.11	22.8	2.96	22.7	69	100
July 1			1.50	1.4	5.53	29.3	.46	0	2.81	10.5	2.58	10.3	62	109
Clubhead:														
April 15							1.66	1.2	.85	2.2	1.26	1.7	48	146
May 1							.97	6.7	2.08	9.2	1.53	8.0	46	134
May 15							1.31	3.7	1.90	10.1	1.61	6.9	48	121
June 1							.78	2.8	2.04	15.0	1.41	8.9	55	107
June 15							1.01	7.5	3.15	15.9	2.08	11.7	56	102
July 1							.56	0.8	3.14	15.0	1.85	7.9	61	99
Freed sorghum:														
April 15	.61	0	.60	0.7	1.13	2.7					.78	1.1	54	107
May 1	.40	0	.95	2.5	.90	2.3					.75	1.6	54	101
May 15	.41	0	.55	2.9	.82	3.4					.59	2.1	56	95
June 1	.63	0	.70	3.8	2.73	21.2					1.35	8.3	52	92
June 15	.60	0	.65	2.9	3.22	30.6					1.49	11.2	58	101
July 1	.40	0	1.40	7.7	2.64	16.1					1.48	7.9	62	101
Feterita:														
April 15	.65	0	.65	3.8	1.44	13.4	1.31	1.7	2.01	13.0	1.21	6.4	42	123
May 1	.48	0	1.65	12.5	1.53	14.1	1.01	1.4	2.21	11.7	1.38	7.9	43	117
May 15	.40	0	1.55	12.7	.97	5.1	1.04	8.6	1.93	11.5	1.18	7.6	44	109
June 1	.80	0	1.90	13.9	3.38	43.5	.65	8.7	1.85	13.9	1.72	16.0	44	107
June 15	1.02	0	.70	10.9	3.79	35.7	1.65	10.9	1.78	14.5	1.79	14.4	51	102
July 1	.80	0	1.10	4.1	3.19	29.0	.19	0	1.83	16.4	1.42	9.9	61	103

It is difficult to draw conclusions from an inspection of these data, except in the light of the previous rather detailed explanation concerning the factors involved in each season's work. One of the outstanding indications of the test is that seeding before May 1 has no advantages over a later seeding. Between May 1 and June 15 the date of seeding should be at whatever time soil conditions are favorable for uniform and prompt germination. When sorghum follows sorghum or Sudan grass the date to seed will probably be later on the average than if sorghum follows a crop less exhaustive of soil moisture. The experiments also indicated the importance of thorough and early work on the seed bed to conserve any moisture that

falls and to kill weeds and volunteer sorghum. From the standpoint of both forage and grain an optimum seeding period of June 1 to 15 is suggested by the average yields obtained; but under more favorable conditions of rotation seeding during the last half of May is considered more satisfactory for grain production, also for forage when a long-season variety, such as Sumac, is used.

The data show the average height of plants to be rather low, indicating in a general way the stunted growth that was often made. The average lengths of the growing season indicate by their abnormal duration the effect of frequent periods in which germination was delayed or growth was retarded by lack of soil moisture.

Feterita was the only variety included in the date-of-seeding experiments at Amarillo, Tex., of both the Offices of Forage-Crop Investigations and of Cereal Investigations. The results with this variety, as indicated in Table 16, agree almost perfectly with the results obtained by the Office of Cereal Investigations (*10*, p. 16). June 1 to 15, therefore, is apparently the best period for seeding feterita in the Texas Panhandle.

EXPERIMENTS AT LAWTON, OKLA.

The date-of-seeding experiments at Lawton, Okla., which were in progress from 1917 to 1921, included only Sumac and Red Amber sorgos. At this station, as at Amarillo, Tex., the sorghums encountered an unusual variety of climatic and other factors, mostly adverse, which must be explained in some detail before the results can be properly interpreted.

The experiments were conducted on duplicate 0.06-acre plats in 1917, single tenth-acre plats from 1918 to 1920, and single 0.06-acre plats in 1921. Records of row space were not obtained except in 1921, but it is known that most of the stands were fairly regular and sometimes too thick for droughty conditions.

The season of 1917 contained intervals in midsummer and in the fall when crops suffered from intense drought. In 1918 drought became very severe in midsummer, causing the seedings of Sumac made on the first three dates to dry up when only 18 inches tall, and the first four seedings of Red Amber also discontinued growth when 33 to 45 inches tall. These plats were cut on August 20, after which rains caused a somewhat better second growth, which was cut on November 5. A rainfall of 8.68 inches in October stimulated this second growth, but caused all previously harvested fodder to become moldy in the shock and very damp when weighed. The season of 1919 was a favorable one for crop growth, but again excessive rainfall in October, 13.78 inches, made proper curing of fodder and seed impossible. In 1920 the April 15 and May 1 seedings were also hurt by drought and damaged in the shock by 8.78 inches of rain in October. The May 15 seeding could not be made on account of excessive rainfall, but seedings on June 3 and 15 came through to normal maturity distinctly superior to the crop from earlier or later seedings. Moisture was ample in 1921 to produce good crops from all the seedings up to and including that of May 15, but drought greatly reduced the yields of plats seeded after that date.

Chinch bugs were always a factor, sometimes preventing a full stand in the late seedings and often causing more or less lodging in those plats.

Data showing how the date of seeding affects the yields of fodder and grain, the height of plants, and the length of time required for sorghums to mature are given in Table 17.

The yield data in this table favor relatively early seeding of Sumac; any time between April 15 and May 15 is good, but preferably about May 1. Short-season varieties like Red Amber may be seeded at any time from April 15 to June 15, but June 1 is perhaps the optimum date. From a practical standpoint, however, the forage yields of Red Amber are so inferior to those of Sumac that the growing of Red Amber is scarcely justified except for late seeding or under conditions where the yield is entirely secondary to quick maturity.

EXPERIMENTS AT WOODWARD, OKLA.

The date-of-seeding experiments at Woodward, Okla., were conducted with Sumac and Red Amber sorgo for the years 1917 to 1921 under rather favorable climatic conditions and without material insect injury. Unreplicated 0.06-acre or 0.08-acre plats were used throughout the experiment. The preceding crop on the land in 1917 and 1920 was cowpeas, and for the other three years sorghum. Uniform stands were obtained throughout the experiments. In 1917 the Red Amber plats were left just as they came up, while the Sumac plats were thinned to 4 inches of row space per plant. In the other years all plats were thinned to approximately 6 inches row space.

Drought was an important factor in 1917 during July and again in October. The July drought so checked the seedings made on April 15 and May 1 that the Red Amber plats of these two dates dried up prematurely and were harvested. Stimulated by the 6.65 inches of rainfall during August these two plats produced a fair second growth, that did not ripen; and all other plats of both varieties, especially Sumac, developed satisfactory forage yields, the harvest having been delayed until the first frost on October 12. The rainfall during the 1918 season was the most poorly distributed, as the drought began in July and continued in some degree the rest of the season. Two cuttings were obtained from the Red Amber seeded on April 15, both cuttings maturing a light crop of seed. Both varieties matured fair crops on all dates of seeding in 1919, though the rainfall was low, because the rain was effectively distributed and the first frost did not come until October 28. The rainfall for 1920 was sufficient to produce the highest forage yields obtained in the five years. A drought period during late July and early August, however, reduced the seed yields of the May seedings of Sumac. The rainfall of 1921 was ample except for about the same period as in 1920, when drought materially decreased the forage yields.

The effect of different dates of seeding on the yields of forage and grain and the average length of the growing season are shown in Table 17.

The average yields differ but little for the first five dates of Sumac and for all the seedings of Red Amber. Inspection of the data on length of season shows clearly, however, how much slower the early seedings, especially of Sumac, were in developing. The June 1

date gave the best results with Sumac and June 15 with Red Amber, when consideration is given to the weed-control problem and the quality of the forage as well as the yields. However, fairly satisfactory forage yields may be obtained by seeding either Red Amber or Sumac as late as July 1 on land that has been given good early preparation.

EXPERIMENTS AT DALHART, TEX.

Date-of-seeding experiments at Dalhart, Tex., were in progress for four years, 1918 to 1921, all relatively favorable seasons. As the experiments in 1918 were only preliminary, covering irregular dates from June 1 to July 9, data from definitely outlined experiments are available for only three years. In these three years seedings of Red Amber and Sumac were made every two weeks from May 1 to June 15. The results obtained are not conclusive; nevertheless, they are suggestive of several practical points that are worthy of consideration.

The experiments were conducted on single tenth-acre plats except in 1921, when single 0.08-acre plats were used. The preceding crop was sorghum or an alternate-row crop of sorghum and cowpeas. The plats were surface planted in 44-inch rows on late-spring plowing.

In 1918 it was impossible to obtain a stand on the June 1 seeding, because of soil conditions; but stands were obtained on June 11, June 25, and July 9. Sumac did not mature on any of these seedings, but Red Amber matured a light seed crop from the sowings on the first two dates. A marked decline in forage yields was evident for both varieties with the progressively later seeding. This result suggested the need for testing earlier dates, so the work was begun on May 1 in the following seasons. The outstanding features of the early seeding dates from 1919 to 1921 were abundant moisture, cold soil, slow germination of the sorghum seed, and vigorous weed growth, which affected adversely the first three seedings each year. The average time required for the May 1 seedings to emerge was 23 days; the May 15 seedings, 15 days; the June 1 seedings, 11 days; and the June 15 seedings, 7 days. The first two dates of Sumac and all the Red Amber matured in 1919, but the plants, which were 7 to 9 feet tall, were badly lodged and tangled during storms of September 15 to 20. In 1920 none of the Sumac matured, but all of the Red Amber ripened naturally. In 1921 the fall was rather hot and dry, hastening the maturity of both varieties and decreasing materially the yields of grain from the Sumac.

The yields of fodder and grain and the average height of plants are shown in Table 17 for both varieties, but the average length of growing season is given for Red Amber only because Sumac failed so often to mature.

These data for Dalhart suggest that it is possible to get fair yields of forage from either Red Amber or Sumac throughout the entire seeding period, May 1 to June 15, and probably as late as July 1. It seems, however, that nothing practical is gained by seeding before the soil is warm, and much trouble from weeds and uncertainty of stands is avoided by deferring seedings for forage until June 1 or later.

EXPERIMENTS AT BIG SPRING, TEX.

Date-of-seeding experiments at Big Spring, Tex., were conducted with Sumac and Red Amber during the three years, 1919 to 1921. The limited data thus obtained are supplemented by rather definite experience acquired incidentally to the sorghum-variety tests of the four preceding years.

The sorghums were surface planted in 44-inch rows on winter-plowed land in single tenth-acre plats. The preceding crop was usually cowpeas. In 1919 moisture conditions were favorable, and excellent yields were obtained from all dates of seeding. The seasons of 1920 and 1921 were fairly satisfactory for forage production, but the soil was considered too dry to attempt seeding until June 1 except for the April 15 tests of 1921.

The yields of forage obtained from the date-of-seeding tests at Big Spring, Tex., together with the average heights and the average lengths of season are shown in Table 17. The yields of seed were not obtained.

The experimental data here presented must be considered in connection with the known seeding conditions of the years 1915 to 1918 in order to justify any conclusions. Decision as to the best date of seeding at Big Spring is based almost entirely on the question of available soil moisture. The frost-free period is long enough to permit the maturity of a crop sown at any date within the limits of those tested, if there is sufficient moisture, as in 1919. The rainfall is extremely irregular and is often distributed in small showers which, on account of the excessive rate of evaporation, are of little if any value. In 1915 there was plenty of rain for seeding in April and any time up to the middle of May, after which it was too dry again until the last of June. Again in 1916 there was moisture in April, but this evaporated rapidly, and May and June were droughty. Throughout 1917 the soil was never wet down more than 4 to 6 inches, and crops were an entire failure. The only opportunity for getting a stand was following a 0.98-inch rain on June 24. In 1918 the only opportunity for seeding was immediately after 3.53 inches of rainfall during the first week of June.

These observations, covering the period from 1915 to 1918 supplemented by the records of 1919 to 1921, indicate that seeding should be attempted the latter part of April or early in May if there is sufficient moisture in the soil. When conditions are not favorable at that time, seeding should be deferred until a rain of 1 inch or more has provided suitable soil conditions.

EXPERIMENTS AT TUCUMCARI, N. MEX.

The date-of-seeding experiments at Tucumcari, N. Mex., were conducted from 1917 to 1921 with Sumac and from 1917 to 1920 with Red Amber. These varieties were seeded at 15-day intervals from April 15 to July 1 as regularly as soil conditions would permit. As at Big Spring, Tex., the data are necessarily rather irregular; still they afford a basis for certain recommendations when considered in connection with the known soil and climatic factors of the experimental period and of preceding years.

All seedings made before June 1 in 1917 and before May 15 in 1919 were ruined by soil blowing. In 1918, 1920, and 1921 no seedings

were attempted before May 15 except of Red Amber in 1918, which was practically a failure. It was too wet for seeding at one date only; namely, on May 15, 1921.

Single twentieth-acre plats were used in 1917, single tenth-acres from 1918 to 1920, and single 0.08-acres in 1921. The sorghums were seeded in 44-inch rows on plowed ground with a surface planter equipped with furrow openers.

The data obtained with reference to yields, height, and length of season are shown in Table 17. The forage yields for 1918 are based on the green weights divided by two.

Factors with reference to the date of seeding sorghum at Tucumcari have been analyzed in detail in Bulletin 130 of the New Mexico experiment station (*3*, p. 20–21). Briefly summarized, the season is sufficiently long to permit seeding at any time from April 15 to July 1 if soil conditions are favorable. Ordinarily the soil is too dry and in danger of blowing until May 15 or later. After May 15 the seeding should be done as soon as there is sufficient soil moisture.

The best average results for forage production are obtained by seeding from June 1 to June 15. Every effort should be made in preparing the seed bed to prevent soil blowing and to conserve as much moisture as possible.

TABLE 17.—*Agronomic data regarding sorghum varieties grown in date-of-seeding experiments at Lawton and Woodward, Okla., Dalhart and Big Spring, Tex., and Tucumcari, N. Mex., in the 5-year period from 1917 to 1921, inclusive.*

[Yields marked with a star (*) are interpolated, seeding being prevented by weather conditions.

Station, variety, and approximate date of seeding.	Yields per acre.										Average.			
	1917		1918		1919		1920		1921		Average.			
	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	Height.	Season.
Lawton, Okla.:														
Sumac—	*Tons*	*Bush.*	*Tons*	*Bush.*	*Tons*	*Bush.*	*Tons*	*Bush.*	*Tons*	*Bush.*	*Tons*	*Bush.*	*In.*	*Days.*
April 15	3.48	3.7	1.53	0	6.05	23.4	9.68	31.9	5.50	33.4	5.25	18.5	60	156
May 1	2.85	2.4	1.66	0	6.60	35.0	10.23	31.9	5.38	32.5	5.34	20.4	61	143
May 15	2.73	4.3	2.06	0	6.30	24.3	*8.70	*38.4	4.67	30.1	4.89	19.4	56	134
June 1	2.79	3.4	2.77	0	5.68	20.4	7.20	41.3	3.84	17.9	4.46	16.6	62	121
June 15	2.83	3.1	1.59	0	6.05	17.0	8.23	33.3	1.42	6.6	4.02	12.0	55	113
July 1	2.63	3.4	1.41	0	4.65	11.3	9.55	21.8	0.84	0	3.82	7.3	54	123
Red Amber—														
April 15	1.31	7.3	.79	0	3.38	28.0	3.63	24.6	4.55	33.9	2.73	18.8	74	136
May 1	1.06	8.1	.78	0	3.40	25.5	4.25	19.4	4.09	32.8	2.72	17.2	73	123
May 15	1.10	8.8	1.38	0	2.73	16.3	*5.12	*26.0	3.21	24.4	2.71	15.1	66	112
June 1	1.10	11.5	.89	0	3.40	30.7	6.18	45.5	2.29	14.9	2.77	20.5	69	103
June 15	1.40	14.7	.47	0	3.43	12.7	5.35	31.7	3.67	15.2	2.86	14.9	66	98
July 1	1.27	8.6	.55	0	3.23	16.3	4.08	22.1	1.17	0	2.06	9.4	57	111
Woodward, Okla.:														
Sumac—														
April 15	7.25	10.0	2.46	2.4	3.28	13.6	7.17	30.4	4.59	35.3	4.95	18.3	.....	163
May 1	7.41	17.6	2.00	0	3.97	13.8	7.46	25.3	5.00	41.1	5.17	19.6	.....	151
May 15	7.53	14.9	2.06	0	3.53	5.1	7.71	23.5	5.04	36.9	5.17	16.1	.....	135
June 1	7.06	20.1	2.19	0	4.34	15.2	8.00	34.5	4.83	40.2	5.28	22.0	.....	123
June 15	6.66	0	1.97	0	4.28	18.1	8.21	37.5	4.29	40.2	5.08	19.2	.....	112
July 1	6.03	0	2.47	1.6	3.78	13.8	6.59	0	3.06	27.2	4.39	8.5	.....	112
Red Amber—														
April 15	2.72	5.8	2.00	12.5	1.71	18.6	3.42	34.5	2.59	24.1	2.49	19.1	.....	114
May 1	2.96	4.6	1.14	6.4	2.50	28.6	3.38	34.5	2.83	30.7	2.56	21.0	.....	103
May 15	2.28	14.7	1.39	9.9	2.66	23.0	3.04	26.2	3.17	27.7	2.51	20.3	.....	103
June 1	2.38	18.5	1.36	9.9	2.19	25.0	4.29	33.9	3.71	31.3	2.79	23.7	.....	97
June 15	2.25	12.9	1.21	8.3	2.69	27.9	4.96	40.5	3.38	34.8	2.90	24.9	.....	97
July 1	1.81	10.5	1.31	9.8	2.84	31.0	4.50	39.6	2.58	21.7	2.61	22.5	.....	98

TABLE 17.—*Agronomic data regarding sorghum varieties grown in date-of-seeding experiments at Lawton and Woodward, Okla., Dalhart and Big Spring, Tex., and Tucumcari, N. Mex., in the 5-year period from 1917 to 1921, inclusive*—Contd.

Station, variety, and approximate date of seeding.	Yields per acre.												Average.	
	1917		1918		1919		1920		1921		Average.			
	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	Height.	Season.
Dalhart, Tex.:	*Tons*	*Bush.*	*Tons*	*Bush.*	*Tons*	*Bush.*	*Tons*	*Bush.*	*Tons*	*Bush.*	*Tons*	*Bush.*	*In.*	*Days.*
Sumac—														
May 1					6.54	16.6	5.28	0	3.69	26.1	5.17	14.2	79	
May 15					6.20	17.1	4.93	0	3.59	15.4	4.91	10.8	79	
June 1					7.68	0	4.25	0	4.63	10.5	5.52	3.5	80	
June 15					6.55	0	5.63	0	7.46	18.2	6.55	6.1	70	
Red Amber—														
May 1					2.75	30.4	3.13	23.2	2.94	35.1	2.94	29.6	84	114
May 15					2.75	23.6	3.05	19.6	3.34	37.7	3.05	27.0	92	100
June 1					3.28	23.2	2.98	27.9	3.53	29.0	3.26	26.7	94	92
June 15					3.08	21.4	3.00	17.3	3.06	31.7	3.05	23.5	80	86
Big Spring, Tex.:														
Sumac—														
April 15					8.16		(1)		5.55		6.86		80	122
May 1					9.20		(1)		(1)				79	130
May 15					10.70		(1)		(1)				80	116
June 1					8.80		7.00		4.06		6.62		69	134
June 15					7.39		7.25		2.92		5.85		68	120
July 1					7.20		7.40		2.42		5.67		74	110
Red Amber—														
April 15					4.90		(1)		2.80		3.85		83	106
May 1					4.22		(1)		(1)				84	92
May 15					5.45		(1)		(1)				82	98
June 1					5.03		3.20		2.01		3.41		66	85
June 15					3.89		2.90		1.30		2.70		58	105
July 1					2.45		1.90		1.00		1.78		64	99
Tucumcari, N. Mex.:														
Sumac—														
April 15	[2]0	[2]0	(3)	(3)	[2]0	[2]0					0	0		
May 1	[2]0	[2]0	(3)	(3)	[2]0	[2]0					0	0		
May 15	[2]0	[2]0	[5]1.35	0	2.20		3.69	5.9	(6)	(6)	1.81	2.0		149
June 1	2.84	0	[5]1.28	0	2.20		3.84	0	4.15	23.0	2.86	5.8	[7]80	131
June 15	4.31	0	[5].75	0	3.55		2.94	0	4.00	5.4	3.11	1.4	[7]71	121
July 1	(4)	0	[5].35	0	2.00		1.85	0	1.81	0	1.50	0	[7]63	112
Red Amber—														
April 15	[2]0	[2]0	.30	0	[2]0	[2]0					.10	0		
May 1	[2]0	[2]0	.25	0	[2]0	[2]0					.08	0		
May 15	[2]0	[2]0	.65	0	1.95		1.46	14.7			1.02	4.9	[8]66	119
June 1	1.51	10.8	.70	0	2.60		1.36	13.2			1.54	8.0	[8]72	116
June 15	2.67	24.1	.98	0	1.85		1.10	10.3			1.65	11.5	[8]69	110
July 1	3.18	25.2	.48	0	1.80		.96	7.9			1.61	11.0	[8]71	103

[1] Seeding not made because soil was too dry.
[2] Seeded, but blown out.
[3] No Sumac seed on hand to plant until May 15.
[4] Yield omitted because of error in weight.
[5] Green weight divided by two.
[6] Too wet to plant until June 1.
[7] Average of 1917 and 1921 only.
[8] Height reported only in 1917 and 1920.

EFFECT OF THE DATE OF SEEDING ON THE RATE OF GROWTH.

Studies were made at Chillicothe, Tex., in 1916 and 1917 to determine what effect the date of seeding had on the growth rate of the sorghums as measured by the height attained at 10-day periods. Freed sorghum, Sumac sorgo, Blackhull kafir, Dwarf milo, and feterita were used in these experiments in order that the response of both early and late varieties might be noted. The results obtained in 1916 are shown in graphic form in Figure 21. The 1917 results were so nearly like those of 1916 that it was not thought necessary to present a graph for each.

The rate of growth for all the varieties is progressively more rapid as the date of seeding becomes later. This tendency is most marked in the earliest two varieties, Freed sorghum and feterita. For the Freed to reach a height of 52 inches the April 10 seeding required 86 days; April 19, 73 days; May 2, 59 days; May 15, 57 days; June

1, 60 days; and the June 16 seeding only 47 days. The only inconsistency in the curve is in the fifth date, June 1. The sorghums seeded on this date all show a more or less decided change in the direction of their individual growth curve about July 12, or 43 days after the seeding date, caused, no doubt, by the practical exhaustion of the

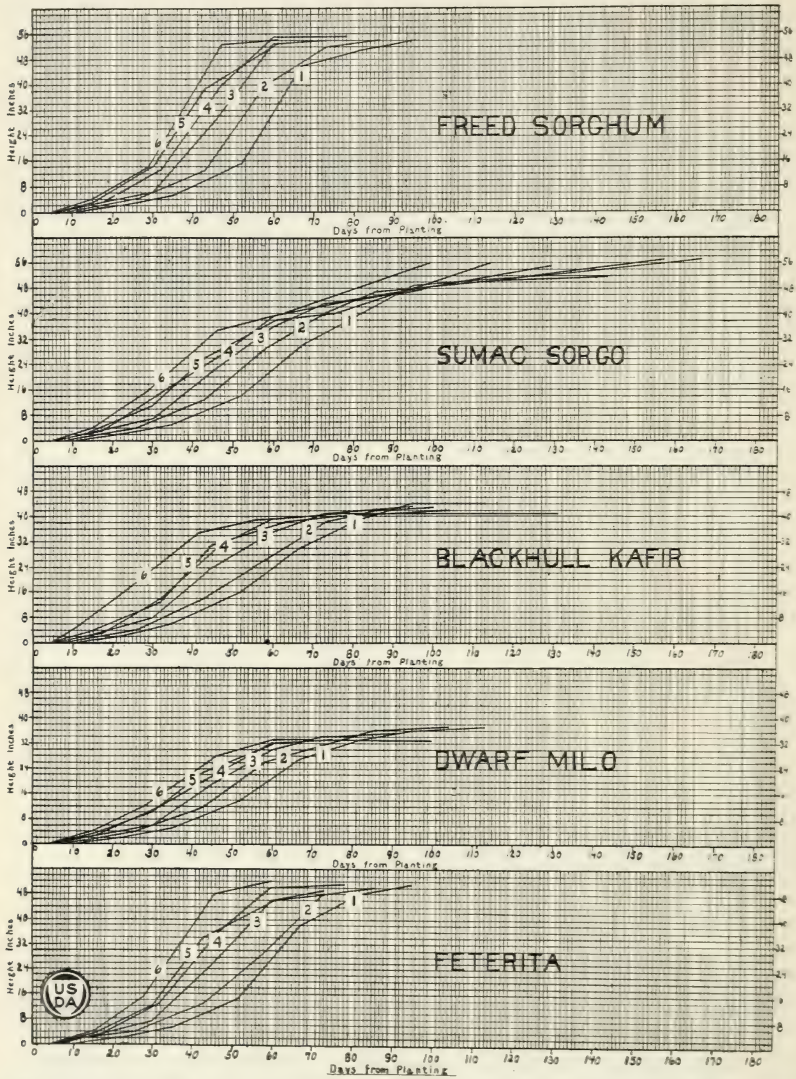

FIG. 21.—Diagrams showing the effect of different dates of seeding on the growth rate of sorghums at Childlicothe, Tex., in 1916. The curves represent seeding dates as follows: 1, April 10; 2, April 19; 3, May 2; 4, May 15; 5, June 1; and 6, June 16.

soil moisture at that time. There had been no effective rains after the rather adequate precipitation in April, except one of 0.72 inch on May 17 and another of the same amount on June 23 and 24. This drought continued until the last week in August, when rain aggregating 0.9 inch fell.

The graph also indicates a difference in the relative growth rate of the varieties. The rates are much alike in Freed sorghum and feterita. Dwarf milo, a variety which has practically the same length of growing season as feterita, is more like Blackhull kafir and Sumac sorgo in its rate of growth. Dwarf milo is therefore early because of its low stature and not on account of the rapidity of its growth. Freed sorghum and feterita, on the other hand, mature quickly, because they grow rapidly when climatic and soil conditions are favorable.

The Blackhull kafir used in these experiments was a dwarf strain (F. C. I. No. 5894) which matured small quantities of seed on nearly all the plats. Sumac sorgo, however, did not mature normally. The manner in which all the Sumac date curves flattened out long before the crop matured shows the effect of a drought in slowing down the growth and lengthening the growing season. The growing season of the varieties which had the slowest rate of growth was naturally lengthened most by the drought. This explains very largely the superiority shown by feterita in years of severe drought.

SUMMARY OF INFORMATION ON DATE OF SEEDING.

While it would be difficult to summarize further in tabular form the experimental data obtained at the eight stations on the best date for seeding sorghum, it is possible to state a number of general principles that are applicable to the entire sorghum belt.

The principal factors which must be considered in determining the best date to seed the sorghums are: (1) Soil conditions, especially as to moisture, temperature, danger of blowing, and freedom from weeds; (2) the available growing season—the normal and extreme limits of the frost-free period; (3) the characteristics of the chosen variety, especially its earliness; and (4) the purpose for which the sorghum is being grown, whether for fodder, silage, or grain.

The results clearly indicate that ordinarily nothing is gained by seeding before the soil is warm, moist, and clean and danger of soil blowing is past. The available time for seeding extends roughly from the average date of the last killing frost in spring to within 90 or 100 days of the average date of the first killing frost in the fall. There is, therefore, in northern Kansas a maximum period of 60 days, from May 1 to July 1, in which seeding can be done. To the southward this period gradually lengthens, until at the most southern stations it lasts from April 1 to August 1, or about 120 days. Seeding sorghum near either limit of the period indicated above is rarely profitable in any part of the sorghum belt. The time limits for seeding the most desirable varieties in order that the grower may avail himself of the best chances of getting a maximum crop are very much reduced.

Irrespective of locality the maximum yields of forage are obtained from sorghum varieties that utilize most fully the entire available growing season. This means that Sumac sorgo will be grown as far north as it can be depended upon to mature, and north of that the Orange and Red Amber or similar varieties will be grown up to and even beyond their limits of maturity. This tendency to use a variety that requires a rather long growing season restricts very much the optimum period for seeding. In the South, where Sumac is grown,

the favorable seeding period may be said to last for six weeks, from May 1 to June 15, with somewhat larger forage yields but less grain from seedings between June 1 and 15.

North of the region where Sumac is the leading variety, the most favorable period for seeding becomes more and more restricted. From the southern boundary of Kansas up to the middle of Nebraska the best period for seeding is between May 15 and June 1. North of this region it is best to seed sorghum during the first week of June.

RATE OF SEEDING IN ROWS.

Frequent newspaper articles have discussed the effect of thin stands on the yields of sorghum, and this question will no doubt continue to be of interest not only to the agricultural press but also to farmers in the semiarid regions. In order to obtain definite information regarding the effect of stand on the yield when the sorghum is grown in rows, it was necessary to classify the experiments according to the row space per plant rather than the rate that the seed was sown. Also, in row seedings the space between the rows affects the stand, and experiments doubling the space between the rows and also leaving out one row in three were conducted at several stations. In addition, the effect of seeding cowpeas in alternate rows with sorghum was tested at Chillicothe, Tex.

In drilled or broadcast seedings the use of different quantities of seed, from 15 to 75 pounds per acre, was tested to determine the effect of the different rates not only on the yield but also on the quality of the hay.

Spacing of Plants in the Row.

Experiments have been conducted at Hays, Kans., and Chillicothe and Amarillo, Tex., to determine the most desirable row space for sorghum plants in rows 40 to 44 inches apart. The plan of these experiments was to sow rather thickly at the most favorable time and to thin the plants by exact count to the desired row space when they were about 5 inches tall. Duplicate twentieth-acre plats were used for these experiments at Hays, Kans.; single tenth-acre plats at Chillicothe, Tex., prior to 1913 and duplicate twentieth-acre plats afterwards; quadruplicated 8-rod rows in 1913 and 1914 at Amarillo, Tex., and duplicate fiftieth-acre plats from 1915 to 1917.

EXPERIMENTS AT HAYS, KANS.

The experiments at the Hays station were in progress from 1914 to 1918 with Red Amber and feterita. The period mentioned included two rather favorable seasons, 1914 and 1915, and three that were medium dry. None were so adverse, however, as the seasons of 1911 and 1913. In the latter season all the plats in a preliminary test of Red Amber dried up without heading, when the plants were less than 18 inches tall. Good stands were obtained in all five years of the regular experiment, although it was necessary to sow the third time in 1915. This was done on June 23, and notwithstanding the late seeding excellent crops were obtained. Both varieties had time to mature in the other years also, although in 1916 most of the Red Amber dried up without heading.

Table 18 shows the effect of differing row spaces on the yields of forage and grain and also on the height of the plants.

TABLE 18.—*Agronomic data regarding sorghum varieties grown in rows 40 inches apart in spacing experiments at Hays, Kans., during the 5-year period from 1914 to 1918, inclusive.*

Variety.	Average row space.		Yields per acre												Average height of plants.
			1914		1915		1916		1917		1918		Average.		
	Per plant.	Per stalk.	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	
	Ins.	*Ins.*	*Tons*	*Bush.*	*Tons*	*Bush.*	*Tons*	*Bush.*	*Tons*	*Bush.*	*Tons*	*Bush.*	*Tons*	*Bush.*	*Ins.*
Red Amber sorgo	2	1.9	3.69	9.9	4.98	27.1	1.44	0.6	2.89	10.7	2.77	2.7	3.15	10.2	66
	4	3.4	3.41	15.1	4.41	29.4	1.07	.9	2.23	6.4	2.75	4.2	2.77	11.2	66
	6	3.6	3.57	18.3	4.40	28.2	1.00	1.2	2.26	8.4	2.74	3.4	2.79	11.9	67
	8	4.2	3.66	23.2	3.78	24.3	1.08	1.8	1.89	8.0	2.62	4.0	2.61	12.3	68
	12	4.7	3.16	22.1	3.68	26.3	1.44	2.0	1.78	8.2	2.66	7.6	2.54	13.2	70
Feterita	4	3.1	3.11	24.6	3.59	34.9	1.58	5.0	2.17	17.5	2.51	12.1	2.59	18.8	60
	8	4.3	3.16	28.9	3.28	33.9	1.43	10.5	1.82	13.2	2.45	19.2	2.43	21.1	60
	12	4.9	3.09	29.6	2.98	26.9	1.09	6.4	1.95	15.0	2.53	16.8	2.33	18.9	58
	16	5.9	2.95	28.3	2.81	22.1	.92	5.4	1.71	15.0	2.45	18.2	2.17	17.8	58
	24	7.2	2.25	21.5	2.59	18.4	.91	6.1	1.37	10.4	2.18	13.9	1.86	14.1	57

From a forage standpoint there is an apparent advantage in favor of the thickest rate for Red Amber. This variety did not, however, always mature normally in the 2-inch stand. Therefore, the 4-inch and 6-inch spacings are perhaps more desirable. For seed production of Red Amber, there was a gradual improvement in quality as well as average yield in proportion to the increased row space per stalk.

In the case of feterita it is noteworthy that, as with Red Amber, the closest spacing produced the highest yield of forage. This factor in feterita, however, is secondary to the yields of grain, which were highest on the plat with 8-inch row space. It is significant that in only one season was the highest grain yield in 40-inch rows obtained at a row space in excess of 8 inches.

EXPERIMENTS AT CHILLICOTHE, TEX.

The row-space experiments at Chillicothe, Tex., were conducted with from five to nine varieties during the 11-year period, 1907 to 1917. Owing to several changes in the outline of the experiments during the earlier years of the work and to unavoidable irregularities of stand in certain seasons, the data on some varieties are not continuous for this entire period. Except for 1912, however, the experiments with Blackhull kafir and Dwarf Yellow milo are complete. During this time there were two years of extreme drought, 1911 and 1913; and three other years—1909, 1910, and 1916—were too droughty for kafir to produce grain. In noting the low average yields for kafir and milo, therefore, it should be considered that the work encountered perhaps more than a normal proportion of adverse seasons.

Table 19 shows for Sumac, Freed sorghum, and feterita the effect of varying row spaces on the yields of forage and grain and the average height of plants.

TABLE 19.—*Agronomic data regarding sorghum varieties grown in rows 40 inches apart in spacing experiments at Chillicothe, Tex., during the 5-year period from 1913 to 1917, inclusive.*

Variety and approximate row space per plant.	Yield per acre.												Average height of plants.
	1913		1914		1915		1916		1917		Average.		
	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	
Sumac sorgo:	*Tons.*	*Bush.*	*Tons.*	*Bush.*	*Tons.*	*Bush.*	*Tons.*	*Bush.*	*Tons.*	*Bush.*	*Tons.*	*Bush.*	*Ins.*
2 inches	0.70	0	7.68	39.3	6.35	15.4	2.73	0	2.73	3.4	4.04	11.6	56
4 inches	.86	0	6.15	39.1	7.50	15.4	2.17	0	3.06	5.9	3.95	12.1	61
8 inches	.83	0	5.73	35.4	8.40	17.5	2.58	0	3.03	6.4	4.11	11.9	63
12 inches	.64	0	6.53	30.9	7.90	14.6	1.89	0	2.69	3.7	3.93	9.8	62
Freed sorghum:													
4 inches	.46	0	4.29	11.4	3.13	23.4	1.57	19.9	1.63	14.4	2.22	13.8	57
8 inches	.48	0	4.45	14.3	1.93	22.1	1.56	19.0	1.03	7.1	1.89	12.5	58
12 inches	.44	0	3.73	16.4	2.45	26.1	1.52	18.9	1.25	10.0	1.88	14.3	59
Feterita:													
4 inches	.37	1.9	------	------	3.30	27.1	1.66	21.4	1.43	10.5	1.69	15.2	50
8 inches	.66	2.8	------	------	3.15	28.2	1.43	19.5	1.14	8.1	1.60	14.7	51
12 inches	.55	3.8	------	------	2.75	26.4	1.39	19.3	1.21	10.9	1.48	15.1	51
16 inches	.47	3.1	------	------	2.50	23.6	1.28	17.2	1.30	10.6	1.39	13.6	51

For convenience in tabulating, the results for Sumac sorgo from 1913 to 1917 are grouped with those of Freed sorghum and feterita, because these varieties were included in the experiments for the same period. The results obtained with these three varieties are inconclusive, and no definite recommendation can be made from them. There is no consistent difference in the yields of either forage or grain attributable to the differing row spaces. A decision as to the best rate of seeding would have to be made in this case on the effect of row space on the size of the heads and quality of the forage, rather than on yields.

TABLE 20.—*Agronomic data regarding Blackhull kafir and Dwarf milo grown in rows 40 inches apart in spacing experiments at Chillicothe, Tex., during a period of 10 stated years.*

Variety and approximate row space per plant.	Yield per acre.											Average height of plants.[1]
	1907	1908	1909	1910	1911	1913	1914	1915	1916	1917	Average.	
BLACKHULL KAFIR.												
Forage (tons):												*Inches.*
4 inches	3.37	2.88	2.00	2.63	1.93	0.78	7.63	3.70	1.50	2.60	2.90	47
8 inches	3.54	2.96	2.00	2.05	2.00	.66	6.48	3.20	1.43	2.24	2.66	47
12 inches	3.18	2.99	2.00	1.85	1.70	.75	5.88	3.20	1.34	3.04	2.59	47
16 inches	3.13	3.13	1.73	1.38	1.40	.71	4.45	2.30	1.13	1.87	2.12	46
Grain (bushels):												
4 inches	------	27.1	0	0	0	0	6.8	26.4	0	11.2	7.9	--------
8 inches	31.3	31.3	0	0	0	0	10.4	28.6	0	16.8	11.8	--------
12 inches	29.8	27.7	0	0	0	0	10.7	27.9	0	9.8	10.6	--------
16 inches	30.0	29.6	0	0	0	0	12.1	21.4	0	7.0	10.0	--------
DWARF MILO.												
Forage (tons):												
4 inches	3.13	2.38	1.73	1.05	.35	.75	5.66	4.65	1.34	1.39	2.24	38
8 inches	3.02	2.45	1.43	1.13	.47	.59	4.49	3.89	1.25	1.30	2.00	38
12 inches	2.23	3.10	1.25	1.33	.52	.64	4.15	4.18	1.32	.82	1.95	37
16 inches	2.78	2.38	.85	.99	.47	.69	4.18	4.00	1.25	1.46	1.91	38
Grain (bushels):												
4 inches	34.5	13.9	10.4	10.7	0	0	23.8	30.0	11.4	6.1	14.1	--------
8 inches	31.8	23.4	10.5	13.2	0	0	19.3	26.4	11.2	5.1	14.1	--------
12 inches	26.1	27.9	10.9	16.1	0	0	21.8	28.6	13.9	2.5	14.8	--------
16 inches	31.1	17.9	7.0	11.4	0	0	21.8	27.1	13.2	6.7	13.6	--------

[1] Data recorded only from 1913 to 1917.

For Blackhull kafir and Dwarf milo, which were included in the tests for a total of 10 years, the results are more illuminating. (Table 20.)

The yields in Table 20 show a consistent decrease in the quantity of forage as the stand becomes thinner. Considering the grain, however, the average yields for each variety are surprisingly uniform except for the 4-inch spacing of Blackhull kafir, and the seasonal fluctuations are not consistent. Such slight differences as are shown, together with accumulated practical experience, indicate that an intermediate spacing of 8 to 12 inches per plant is best.

EXPERIMENTS AT AMARILLO, TEX.

Spacing experiments were in progress at Amarillo, Tex., throughout the five years, 1913 to 1917. Three varieties, Sumac sorgo, Dwarf milo, and feterita, were included in the tests. Blackhull kafir was grown from 1913 to 1915, after which Dawn kafir, a better adapted variety, was substituted. Tests with Freed sorghum were attempted for three years but without success, because birds took the seed, and in 1916 and 1917 Red Amber was substituted for this variety.

Shortage of land made it necessary to conduct these tests in smaller plats than usual; in single rows replicated four times or in duplicate 2-row plats. It was also necessary to grow sorghums continuously on the same land. With the opening of each season, therefore, the soil was in poor physical condition, and the crops were dependent entirely on seasonal precipitation for germination and growth. In the extremely adverse season of 1913 marginal influences were somewhat of a factor in the yields, and most of the seedings were so nearly a failure that the data are not presented. In 1916 a prolonged drought at seeding time made it impossible to secure proper stands, but quite satisfactory stands were obtained in the other seasons. The data recorded for 1914, 1915, and 1917 are given in Table 21.

TABLE 21.—*Agronomic data regarding sorghum varieties grown in rows 40 inches apart in spacing experiments at Amarillo, Tex., in 1914, 1915, and 1917.*

Variety.	Average row space.		Yields per acre.								Average height of plants.
			1914		1915		1917		Average.		
	Per plant.	Per stalk.	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	Forage.	Grain.	
	Inches.	*Inches.*	*Tons.*	*Bush.*	*Tons.*	*Bush.*	*Tons.*	*Bush.*	*Tons.*	*Bush.*	*Inches.*
Sumac sorgo	2.7	2.0	3.45	0	8.53	19.2	3.05	0	5.01	6.4	66
	4.0	2.8	3.05	0	8.03	17.9	3.38	0	4.82	6.0	68
	5.9	3.2	2.90	0	7.60	18.8	3.75	0	4.75	6.3	68
	7.5	3.9	2.40	0	8.10	15.6	3.73	0	4.74	5.2	67
Blackhull kafir	4.8	3.6	2.90	1.8	4.48	42.9	3.53	11.2	3.64	18.6	49
	7.3	4.6	2.05	3.6	4.25	37.9	3.28	12.1	3.19	17.9	48
	10.4	5.9	2.55	7.1	3.98	42.9	2.98	11.4	3.17	20.5	49
	14.6	8.4	1.85	5.9	3.55	33.5	2.43	10.1	2.61	16.5	49
Dwarf milo	5.2	3.3	1.80	6.8	4.45	67.9	2.18	14.3	2.81	29.7	36
	8.1	3.7	2.00	8.6	4.21	65.2	2.08	11.4	2.76	28.4	36
	11.4	4.2	1.55	11.1	3.93	64.3	2.08	11.4	2.52	28.9	35
	15.5	5.2	1.35	15.7	3.53	63.8	1.93	9.8	2.27	29.8	35
Feterita	5.4	3.7	2.00	5.7			2.55	15.6			
	8.0	4.2	1.60	5.9	3.91	52.7	2.73	20.8	2.75	26.5	38
	12.1	4.7	1.45	8.9	3.60	52.7	2.25	21.9	2.43	27.8	49
	16.2	5.4	1.30	7.5	3.70	49.6	2.80	21.4	2.60	26.2	49

The results of these experiments at Amarillo are not in themselves a sufficient basis for specific recommendations, but their main features support the tentative conclusions that were deduced from the work at Hays and Chillicothe. The closer the spacing, the higher the average forage yields by a small but consistent margin. The grain yields are not at all decisive in themselves, but they indicate the reliability of an 8-inch to 12-inch row space for grain production.

Spacing of the Rows.

Since it is possible to vary the number of plants per acre by varying the space between the rows as well as the spacing of plants in the row, experiments were carried out at Hays, Kans., and Chillicothe, Tex., to determine the effect of differing spaces between the rows on the yields of forage and grain. The experiments at Hays

FIG. 22.—Pink kafir in 80-inch rows at Hays, Kans., in 1919. The plat in the foreground had been thinned to a 12-inch row space per plant.

were conducted with Pink kafir on duplicated twentieth-acre plats for the years 1919 to 1922, and at Chillicothe from 1918 to 1922 with both Dwarf kafir and feterita on twentieth-acre plats. The spacing of plants in the row was arranged at both places, so that comparisons could be made of different row spaces in plats which had the same number of plants per plat.

EXPERIMENTS AT HAYS, KANS.

Pink kafir was used in the experiments at Hays, because it is a variety well adapted to climatic conditions there and can be depended upon to produce fair yields of both forage and grain. Climatic conditions during the progress of the experiment were rather favorable, and the stands obtained were uniformly good. Table 22 shows the yields of Pink kafir in rows 40 and 80 inches apart, also rows alternately 40 and 80 inches. (Figs. 7, 22, and 23.) These three methods of arranging the rows are compared by using four rates of row space.

TABLE 22.—*Yields of Pink kafir when seeded in rows different distances apart at Hays, Kans., in stated years.*

Plants per acre.	Spacing (inches).		Air-dry fodder per acre (tons).					Threshed grain per acre (bushels).				
	Width of rows.	Row space per plant.	1919	1920	1921	1922	Average.	1919	1920	1921	1922	Average.
Thick (26,400 plants)	40	6	3.27	4.13	4.36	3.19	3.74	39.3	49.6	58.1	34.8	45.5
	[1]40–80	4	2.68	3.80	4.13	2.88	3.37	40.8	50.4	56.3	33.7	45.3
	80	3	2.47	3.49	3.93	2.58	3.12	38.9	46.1	53.5	31.9	42.6
Medium thick (13,200 plants)	40	12	2.95	3.56	3.97	2.58	3.27	45.7	32.9	52.9	29.9	40.4
	[1]40–80	8	2.68	2.88	3.49	2.41	2.87	44.8	33.9	49.2	33.0	40.2
	80	6	2.26	2.84	3.21	2.26	2.64	36.8	34.6	46.3	31.8	37.4
Medium thin (8,800 plants)	40	18	2.63	3.52	3.40	2.08	2.91	35.7	31.8	41.9	21.2	32.7
	[1]40–80	12	2.48	3.27	3.28	1.95	2.75	37.0	32.3	45.8	25.9	35.3
	80	9	2.13	2.96	3.10	1.94	2.53	32.7	32.3	46.0	26.6	34.4
Thin (6,600 plants)	40	24	2.50	2.98	3.13	2.19	2.70	29.1	33.2	43.5	26.0	33.0
	[1]40–80	16	2.12	2.71	3.10	1.85	2.45	30.4	31.6	44.2	25.9	33.0
	80	12	1.85	2.39	3.00	1.73	2.24	28.0	30.2	45.3	24.7	32.1

[1] In this plat the rows were alternately 40 and 80 inches apart. Thus, each row was adjacent to an 80-inch space on one side and a 40-inch space on the other.

FIG. 23.—Pink kafir in alternating 40-inch and 80-inch rows at Hays, Kans., in 1919. The plat in the foreground had been thinned to a 12-inch row space per plant.

The yields shown in Table 22 indicate a slight advantage in the 40-inch over the 80-inch row space for both forage and grain. The average yield of forage from the 40-inch rows was also larger than that from the rows alternately 40 and 80 inches apart; the grain yield, however, was largest on the alternate 40 and 80 inch rows. The average yields per acre for the four years and the four rates of the 40, 40 and 80, and 80-inch rows were 37.9, 38.5, and 36.6 bushels

of grain and 3.16, 2.86, and 2.63 tons of fodder, respectively. The differences in yield are almost negligible, considering the whole period and all the rates. If we consider only the thick rate, we find a spread of approximately 3 bushels per acre of grain and 0.6 ton of fodder in favor of the 40-inch over the 80-inch row space; comparing the 40-inch and the alternate 40 and 80-inch rows, we find that the average grain yields are equal and the fodder yield only 0.3 ton per acre greater from the 40-inch rows.

The very consistent increase in both the forage and grain yields as the number of plants per acre is increased is noteworthy. This increase is apparent for each row space, and the average yields for the thick seeding are greater than those of the thin seeding by approximately 1 ton of fodder and 10 to 12 bushels of grain. It should be pointed out, however, that climatic conditions were rather favorable throughout the period of this experiment, and it is probable that the thinner rates and wider spaced rows would make a better showing in adverse or droughty seasons.

EXPERIMENTS AT CHILLICOTHE, TEX.

Climatic conditions at Chillicothe during the period covered by the experiments were much less favorable than at Hays, Kans., especially in 1918 and 1922. Regardless of this fact the stands obtained were for the most part uniform and the row space very near that outlined for the different plats. The alternate 40 and 80-inch row test was not introduced into the experiment until 1920; hence, two averages are given, one for the 5-year period, 1918 to 1922, and the other for the three years, 1920 to 1922. An added feature of the Chillicothe experiment was the seeding of sorghum in rows 80 inches apart with a row of cowpeas between. The yields obtained from the different methods of seeding are shown in Table 23.

TABLE 23.—*Yields of Dwarf kafir and feterita when seeded in rows different distances apart at Chillicothe, Tex., in stated years.*

Variety	Spacing (inches).		Air-dry fodder per acre (tons).							Threshed grain per acre (bushels).						
	Width of rows.	Row space per plant.	1918	1919	1920	1921	1922	Average. 1918 to 1922	Average. 1920 to 1922	1918	1919	1920	1921	1922	Average. 1918 to 1922	Average. 1920 to 1922
Dwarf kafir	40	16	0.88	2.28	2.27	1.85	1.50	1.76	1.87	0	24.8	30.1	16.3	13.4	16.9	19.9
	80	8	.75	2.03	2.33	1.36	1.01	1.50	1.57	4.5	22.9	31.4	15.9	16.0	18.1	21.1
	40	8	1.00	2.49	2.49	2.11	1.76	1.97	2.12	0	25.6	29.5	22.8	7.7	17.1	20.0
	80	4	.86	2.13	2.33	1.89	1.26	1.69	1.83	0	23.3	33.1	20.1	14.5	18.2	22.6
	[1] 40–80	6	----	----	2.34	1.32	1.36	----	1.67	----	----	29.2	16.0	11.5	----	18.9
	[2] 80–C	8	.74	1.56	2.12	1.11	.97	1.30	1.40	0	16.1	30.9	11.8	4.1	12.6	15.6
Feterita	40	16	.34	2.42	2.23	1.32	1.15	1.49	1.57	1.8	37.2	34.7	29.1	26.4	25.8	30.1
	80	8	.48	1.73	1.67	.96	.92	1.15	1.18	3.3	28.9	32.8	22.1	27.9	23.0	27.6
	40	8	.30	2.48	2.26	1.51	1.18	1.55	1.65	1.5	39.0	37.0	30.7	28.8	27.4	32.2
	80	4	.49	1.86	2.12	.98	.92	1.27	1.34	2.1	31.5	35.2	30.1	25.9	25.0	30.4
	[1] 40–80	6	----	----	2.16	1.36	1.01	----	1.51	----	----	35.5	20.0	28.8	----	28.1
	[2] 80–C	8	.39	1.89	1.50	.78	.89	1.09	1.06	1.3	22.8	29.2	18.3	22.9	18.9	23.5

[1] In this plat the rows were alternately 40 and 80 inches apart. Thus, each row was adjacent to an 80-inch space on one side and a 40-inch space on the other.

[2] In this plat the rows were 80 inches apart, with a row of cowpeas between.

The average yields of forage for both the long and short period confirm the results at Hays and indicate that the regular row space (40 inches) will produce the most fodder. This is true for both Dwarf kafir and feterita. In addition, the thicker the plants are in the rows the greater the forage yield. Contrary to the results obtained at Hays, the alternate 40 and 80 inch rows did not outyield the 80-inch rows in the kafir. With feterita, however, the reverse is true. Placing a row of cowpeas between the 80-inch rows of sorghum decreased both the grain and forage yields appreciably.

The grain yields of the kafir plats were not so consistent as those at Hays. This was owing to the low yield in 1922 of the 40-inch rows with 8-inch spacing in the rows. The failure of this thickest rate to produce grain was caused by the late seeding of the duplicate plat. Because of continued rains the first seeding, which should have been made on May 1, was delayed to May 12. The second seeding, planned for May 14, was made May 26. The kafir seeded on May 26 did not have time to head before the drought became severe in July, and very few heads emerged in the 40-inch rows. The plats seeded May 12 and the thinner rates of the May 26 seeding did not suffer from the drought so much and therefore made a better showing. If the seedings had been made on the dates planned, the 40-inch rows would no doubt have made the best average yield of grain.

The feterita grain yields were largest in the 40-inch rows, owing to the early maturity of this variety, which enabled it to head out before the drought became severe. The only disagreement in the feterita grain yields at Chillicothe and those of the Pink kafir at Hays was in the yields of the alternate 40 and 80-inch rows, which produced less than the 80-inch rows.

The experiments in row width at Hays, Kans., and Chillicothe, Tex., although perhaps not so extensive as they should be for definite conclusions, indicate that larger yields may be expected from rows spaced the ordinary distance rather than 80 inches apart. With equal yields the 80-inch spacing would be preferable, because the heads are larger and more easily harvested. The wide spaces between rows are also a measure of insurance against drought injury, and the soil is left in better condition for the following crop.

The spacing experiments of the Office of Cereal Investigations at Amarillo, Tex. (*10*, p. 23–36), confirm the results recorded in this bulletin in respect to the fodder or total crop yield. For the grain yields, however, their results are more favorable to the widely spaced rows.

Quantity of Seed Required to Obtain a Stand.

In order to determine the relation of row space per plant to the quantity of seed sown, experiments were planned to discover how nearly the germination of sorghum seed in the field approaches that obtained in the laboratory; also, how many pounds of seed per acre are ordinarily required to produce a stand with the desired row space per plant. These facts are necessary in order to apply in actual farm practice the information obtained regarding the most desirable row space.

COMPARISON OF FIELD AND LABORATORY GERMINATION.

These experiments were conducted for two years at Amarillo, Tex. In 1914 300 seeds each of five varieties were drilled in rows at 2-week intervals from April 1 to June 1, and in 1915 from April 1 to July 15. After the emergence of the plants seemed to be completed a count was made, and four or five days later the plants were counted a second time to make sure that the full germination was obtained. The results of these field germination tests are given in Table 24.

TABLE 24.—*Laboratory germination tests of sorghum seed compared with field tests at Amarillo, Tex., in 1914 and 1915.*

Variety and date seeded.	1914				1915					
	Soil condition.	Days to emerge.	Germination (per cent).		Soil condition.	Days to emerge	Germination (per cent).		Average germination (per cent).	
			Laboratory.	Field.			Laboratory.	Field.	Laboratory.	Field
Blackhull kafir:										
Apr. 1	Dry	41	96	12.8	Wet	26	98.5	10.0	97.3	11.4
Apr. 15	do	27	96	69.0	do	15	98.5	32.8	97.3	50.9
May 1	Wet	8	96	24.3	do	15	98.5	34.8	97.3	29.6
May 15	do	7	96	14.3	do	10	98.5	66.0	97.3	40.2
June 1	Moist	12	96	58.6	do	6	98.5	65.2	97.3	61.9
June 15					Moist	14	98.5	18.0		
July 1					Dry	11	98.6	42.8		
July 15					Moist	6	98.5	70.0		
Dwarf milo:										
Apr. 1	Dry	41	94.5	8.0	Wet	26	96.5	42.4	95.5	25.2
Apr. 15	do	27	94.5	47.3	do	15	96.5	47.4	95.5	47.4
May 1	Wet	8	94.5	21.0	do	15	96.5	50.6	95.5	35.8
May 15	do	7	94.5	11.3	do	10	96.5	67.8	95.5	39.6
June 1	Moist	12	94.5	38.3	do	6	96.5	73.4	95.5	55.9
June 15					Moist	14	96.5	23.0		
July 1					Dry	11	96.5	35.4		
July 15					Moist	6	96.5	73.4		
Feterita:										
Apr. 1	Dry	41	99.5	12.2	Wet	26	90.0	14.6	94.8	13.4
Apr. 15	do	27	99.5	49.3	do	15	90.0	25.8	94.8	37.6
May 1	Wet	8	99.5	20.3	do	15	90.0	23.8	94.8	22.1
May 15	do	7	99.5	16.6	do	10	90.0	34.6	94.8	25.6
June 1	Moist	12	99.5	61.3	do	6	90.0	45.8	94.8	53.6
June 15					Moist	14	90.0	10.4		
July 1					Dry	11	90.0	18.4		
July 15					Moist	6	90.0	39.0		
Black Amber sorgo:										
Apr. 1	Dry	41	99.5	25.2	Wet	26	95.0	41.2	97.3	33.2
Apr. 15	do	27	99.5	65.6	do	15	95.0	47.6	97.3	56.6
May 1	Wet	8	96.5	74.6	do	15	95.0	37.0	97.3	55.8
May 15	do	7	99.5	28.0	do	10	95.0	55.2	97.3	41.6
June 1	Moist	12	99.5	51.3	do	6	95.0	63.0	97.3	57.2
June 15					Moist	14	95.0	29.0		
July 1					Dry	11	95.0	39.8		
July 15					Moist	6	95.0	56.8		
Sumac sorgo:										
Apr. 1	Dry	41	98	15.2	Wet	26	98	36.8	98	26.0
Apr. 15	do	27	98	65.0	do	15	98	38.4	98	51.7
May 1	Wet	8	98	67.3	do	15	98	45.2	98	56.3
May 15	do	7	98	24.3	do	10	98	62.4	98	43.4
June 1	Moist	12	98	56.6	do	6	98	46.0	98	51.3
June 15					Moist	14	98	21.2		
July 1					Dry	11	98	42.0		
July 15					Moist	6	98	68.6		

It will be noted that the quality of the seed was unusually good, none of the lots germinating less than 90 per cent in the laboratory. The very much lower percentage of germination obtained in the field explains the necessity of using a much larger quantity of seed than is theoretically necessary to obtain a given stand of plants.

Germination of seed in the field depends to a great extent on soil conditions; therefore the results for the individual years if studied in connection with the indicated soil condition at seeding time are more reliable than the averages. The first four months of 1914 were exceedingly dry, no effective rains being received until May 1. A rain of 0.6 inch on April 6 and 7 probably accounted for what germination was obtained from the April seedings. The temperatures in 1914 during the period of the test were more favorable than in 1915. Considering all the varieties, better germination was obtained from the April 15 and June 1 seedings than from any other. Even on these dates the field germination was only 50 to 60 per cent of that obtained in the laboratory, and on the less favorable dates as low as 12 per cent.

In the spring of 1915 the climatic conditions were very different from those in 1914. Rains began early in April and were abundant until June 6. The latter part of June was very dry, but effective rains began again on July 12. Although soil conditions were for the most part favorable to germination in 1915, the temperatures were unfavorable. April and the first part of May were cold, and this no doubt lowered the germination percentage obtained in the field.

A large part of the sorghum acreage is seeded between April 15 and June 1. The average percentages of the field germinations for the four seedings during this period were as follows: Blackhull kafir, 45.7; Dwarf milo, 44.7; feterita, 34.7; Black Amber sorgo, 52.8; and Sumac sorgo, 50.7. Stated in percentages of laboratory germination, the averages are: Blackhull kafir, 46.3; Dwarf milo, 46.3; feterita, 38.6; Black Amber sorgo, 55.6; and Sumac sorgo, 51.7. Although conditions were on the whole rather better than normal in 1915, the best field germinations were only 75 per cent of the laboratory germination. On the average, it would seem best to expect in field seedings about half the germination obtained in laboratory tests.

RELATION OF QUANTITY OF SEED SOWN TO ROW SPACE OBTAINED.

The work at Amarillo in 1914 and 1915 indicated that it is best to expect in field seedings of kafir, milo, and sorgo not more than 50 per cent of the laboratory germination and of feterita not over 40 per cent. The approximate number of seeds in a pound of Dwarf kafir is 24,000, Orange sorgo, 23,500, and Sumac sorgo, 37,500. With these facts, it is possible to calculate a theoretical stand, but such a calculated stand, even with the field germination reckoned at half the laboratory germination, is thicker than that obtained in actual field work, as may be seen in Table 25.

The experiment to determine what adjustment of the planter is necessary to deliver 1, 2, 3, or 4 pounds of seed into the soil and what stand will ordinarily result from these differing quantities of seed was begun at Chillicothe, Tex., in 1919. That year the work was largely preliminary, and the experiment in its final form did not start until 1920. Rows 20 rods long each of Dwarf kafir and Sumac and Orange sorgo were seeded on two dates. The adjustment of the planter did not result in sowing the quantities of seed desired except of Sumac sorgo. The actual quantity sown in each case is, however,

indicated in the table. In 1920 the first seeding was made on May 3 and the second on May 19; in 1921 the seedings were made May 16 and June 20, and in 1922 on May 12 and June 15. The average percentage of germination of the seed for the three years was, for the Dwarf kafir, 94.7; Sumac sorgo, 96.3; and Orange sorgo, 93.5. The results of this test, which are given in Table 25, are fairly consistent for all the varieties.

TABLE 25.—*Row space obtained with three varieties of sorghum when approximately 1, 2, 3, and 4 pounds of seed per acre were drilled with a corn planter adjusted as indicated, at Chillicothe, Tex., in 1920, 1921, and 1922.*

Variety.	Holes in the planter plate.		Gear speed.[1]	Seed per acre (pounds).	Actual row space per plant (inches).				Theoretical average row space (inches).[2]
	Number.	Diameter (inches).			1920	1921	1922	Average.	
Dwarf kafir	6	Three-sixteenths	Fast	1.094	10.13	19.22	30.93	20.09	12.61
	12	do	Slow	1.563	10.94	7.20	9.23	9.12	8.83
	12	do	Fast	2.031	4.81	6.98	15.90	9.23	6.79
	18	do	do	2.813	5.22	4.41	10.42	6.68	4.91
Sumac sorgo	6	do	Slow	1.250	7.84	10.03	14.40	10.76	6.95
	12	do	do	2.266	4.41	6.19	16.43	9.01	3.83
	12	do	Fast	3.047	4.71	5.25	8.59	6.18	2.85
	18	do	do	4.219	2.60	3.10	8.72	4.81	2.06
Orange sorgo	6	do	do	.860	11.75	12.63	19.89	14.76	16.59
	18	do	do	2.476	5.47	5.03	10.56	7.02	5.77
	12	One-fourth	Slow	3.380	3.79	4.06	9.51	5.79	4.22
	20	do	do	5.000	2.78	3.08	7.42	4.43	2.85

[1] At the fast-gear speed the plate makes one complete revolution to each revolution of the wheels. At the slow-gear speed the plate makes only three-fourths of a revolution to each revolution of the wheels.
[2] The theoretical average row space per plant is calculated on the assumption that the germination in the field should be 50 per cent of the laboratory germination for these varieties.

At Chillicothe, Tex., during the three years, 1920 to 1922, 3 pounds of Dwarf kafir seed drilled in well-prepared soil with an ordinary corn planter resulted in an average row space of about 7 inches per plant rather than 5 inches, and 2 pounds of seed resulted in 9 inches of row space rather than 7 inches.

Sumac sorgo seed drilled in the same way at 4 pounds per acre resulted in a 5-inch average row space rather than 2 inches; at 3 pounds per acre, 6 inches rather than 3 inches. Lesser quantities of seed gave about the same actual results as compared with the theoretical.

With Orange sorgo seed the results were about the same as for Sumac sorgo and Dwarf kafir. With only one exception the stand obtained was thinner than the expected stand, even when the field germination was computed at 50 per cent of the laboratory germination.

Summary of Information on Rate of Seeding in Rows.

In all the experiments at Hays, Kans., and Chillicothe and Amarillo, Tex., it is apparent that the total crop or forage yield is slightly larger the closer the spacing within the limits tested. In some seasons, however, when there was a severe drought, the thickest rates were injured more than the thin rates, with a consequent lowering of the quality of the fodder. For grain production the intermediate rates, with 8 to 12 inches of row space, gave the best quality of seed.

though not always the highest yield. The heads in the thicker rates were more numerous but much smaller and sometimes poorly exserted and filled. With a row space in excess of 12 inches there is an increasingly marked tendency with some varieties, especially feterita, to produce a portion of the crop on sucker stalks or branches that mature late and have poorly filled heads. This lack of uniformity interferes with machine harvesting and results in a poor quality of grain that is likely to heat in storage.

The experiments with differing spaces between the rows, especially those with Pink kafir at Hays, Kans., produced additional evidence in favor of fairly thick stands. A 6-inch row space in 40-inch rows having 26,400 plants to the acre produced 1.04 tons more air-dry fodder and 12.5 bushels more grain per acre than a 24-inch row space having 6,600 plants per acre; in rows with alternately 40 and 80 inches of space between them 26,400 plants per acre produced 0.92 ton more fodder and 12.3 bushels more grain than 6,600 plants per acre; and in 80-inch rows the difference in favor of the thick stand was 0.88 ton of fodder and 10.5 bushels of grain. The 40-inch rows produced more fodder and practically as much grain as the wider rows during the period of the experiment, which was somewhat more favorable than normal.

These rate-of-seeding experiments indicate that a 4-inch row space is best for forage purposes, and an 8-inch to 12-inch row space for grain yields. However, the row space and the space between the rows are factors of less importance apparently than the choice of varieties.

Experiments planned to determine the methods best suited to obtain in actual farm practice stands with the desired row space per plant showed that the germination of seed in the field averaged about 50 per cent of the laboratory germination. At Chillicothe, Tex., 1.5 to 2 pounds of kafir seed per acre resulted in a stand with approximately 9 inches of row space per plant, and 3 pounds of seed gave a stand with about 7 inches of row space. With Sumac sorgo seed 1 pound gave a stand with approximately 11 inches of row space; 2 pounds, 9 inches; 3 pounds, 6 inches; and 4 pounds, 5 inches. With Orange sorgo seed 1 pound gave a stand with approximately 15 inches of row space; 2.5 pounds, 7 inches; 3.4 pounds, 6 inches; and 4.3 pounds, 4.5 inches.

It is believed that in a test covering a longer period of years or in a locality where conditions were more favorable for germination the results would more closely approach the theoretical average row space shown in the last column of Table 15.

RATE OF SEEDING IN CLOSE DRILLS OR BROADCAST.

The two methods of seeding sorghum most commonly practiced are seeding in rows 40 to 44 inches apart, previously described, and seeding in close drills or broadcast. The former method presupposes cultivation of the crop after the manner of cultivating corn; whereas, the latter permits no cultivation, and the crop is harvested usually with haying machinery. When a grain crop is desired the sorghums are nearly always seeded in rows, the close-drilled or broadcasted sorghums being almost invariably harvested for hay.

The average yields of forage obtained by the two methods at Hays, Kans., and Chillicothe, Tex., are similar over a period of five years or

more, as will be observed by comparing the yields in Table 26 with the forage yields of the same varieties in Tables 18 and 19. In years of low rainfall the row sorghums ordinarily outyield those sown in close drills, and the quality of the forage is superior because of the more normal maturity of the row seedings. In years of abundant rainfall, however, the reverse is true; the close-drilled sorghums outyield the row sorghums, and the quality of the forage is first-class. Some variety of sorgo is usually chosen for close-drilled seedings, kafir or other grain sorghums being used only in rare instances.

Experiments in the rate of seeding sorgo in close drills were conducted at the same field stations as the rate experiments in row seedings. The results at Amarillo, Tex., however, were of minor value because the outline was changed several times. The results obtained at Hays, Kans., with Red Amber sorgo and at Chillicothe, Tex., with both Red Amber and Sumac are shown in Table 26.

TABLE 26.—*Yields of forage from sorgo varieties seeded in close drills at different rates at Hays, Kans., and Chillicothe, Tex., in stated years.*

Variety, location, and seed per acre.	Yields per acre of air-dry hay (tons).							
	1914	1915	1916	1917	1918	1921	1922	Average.
Red Amber at Hays, Kans.:								
15 pounds	4.24	6.81	1.79	2.99	3.25			3.82
30 pounds	3.98	6.91	1.83	2.67	3.16			3.71
45 pounds	3.74	7.16	1.84	2.65	2.52			3.58
60 pounds	3.62	7.13	1.82	3.10	2.53			3.64
75 pounds	3.75	7.17	1.64	2.59	3.17			3.66
Red Amber at Chillicothe, Tex.:								
15 pounds	6.13	5.25	1.35	.87		2.94	2.90	3.24
30 pounds	6.83	5.93	1.48	.99		3.40	3.55	3.70
45 pounds	7.23	6.25	1.26	.92		4.56	3.47	3.95
60 pounds	7.28	6.05	1.27	.93		3.94	3.34	3.80
75 pounds	6.98	5.50	1.21	1.01		4.24	3.72	3.78
Sumac at Chillicothe, Tex.:								
15 pounds	8.50	6.30	1.10	.88		4.12	3.53	4.07
30 pounds	8.70	6.05	1.15	.92		4.52	3.91	4.21
45 pounds	9.35	6.68	1.01	.97		4.22	3.93	4.36
60 pounds	9.88	6.25	.74	.74		4.01	3.87	4.25
75 pounds	9.85	6.75	.38	.83		4.13	4.07	4.34

At Amarillo, Tex., the yields from the drilled plats were low except in 1915, a season of abundant rainfall. The average yields per acre of Red Amber sown in 1914, 1916, and 1917 at the 15-pound rate were 1.87 tons; 30-pound rate, 1.98 tons; 45-pound rate, 1.78 tons; and 60-pound rate, 1.68 tons. The average yields of Sumac for the same years and rates of seeding were 1.88, 1.83, 1.78, and 1.81 tons per acre, respectively. In these three rather dry years the lower rates made the higher yields.

Red Amber seeded in rows during the same years produced an average of 2.33 tons and Sumac 3.3 tons of air-dry fodder per acre. It is apparent, therefore, that seeding in rows is the most dependable method of growing sorghums for forage in the northern Panhandle of Texas.

Throughout all the tests in close drills, it is apparent that varying the rate of seeding affected but little the tonnage produced. It seems that with a given amount of moisture, about the same amount of plant growth can be made irrespective of rate of seeding within the limits tested. The quality of the forage, however, is a factor of im-

portance in most seasons. There was a tendency at Hays, for example, for the 15-pound seedings to produce relatively coarse as well as taller plants. Many of the stalks of plants sown at the 15-pound rate were approximately half an inch in diameter, and a considerably greater number headed than in the thicker seedings. The diameter of stalk decreased proportionately with the increase in seeding rates, so that in the 75-pound seedings it averaged only about a quarter of an inch or very little more than that of vigorous Sudan grass. (Fig. 24.) Decreasing coarseness of stems is an advantage, but it was offset in many cases by a more stunted growth. It is not uncommon for all the close-drilled seedings to head poorly or not at all during droughty seasons, and in such cases the thicker the seeding rate the sooner have the plants ceased to grow and develop normally.

All things considered, it appears that a rate of 30 to 45 pounds to the acre is desirable for close-drilled seedings of sorgo in that part

FIG. 24.—Red Amber sorgo seeded in close drills at Hays, Kans., in 1915. The plat on the left was seeded at the rate of 15 pounds and that on the right at 75 pounds per acre.

of the sorghum belt having less than 25 inches average annual rainfall. The exact quantity of seed to use will vary within these limits according to the size of the seed. Sumac sorgo has about a third more seeds to the pound than Red Amber. Purity and germination of the seed as well as soil conditions at the time of seeding must also be considered. Under any conditions tending to prevent satisfactory germination in the area above specified, one might be justified in increasing the rate to 60 pounds. In more humid areas higher rates are preferred, usually from 1 to 2 bushels per acre.

TIME OF CUTTING SORGHUM FOR HAY.

Close-drilled seedings of Red Amber sorgo were used for experiments on the time of cutting at Hays, Kans., during the six years 1917 to 1922, inclusive. Duplicate twentieth-acre plats were seeded at either 30 or 45 pounds per acre for each time of cutting and the

sorgo was cut each year at four different stages of maturity. These stages can not be closely defined, owing to the fact that the sorghum made a normal growth each season only until it reached approximately the first head stage, after which it usually showed marked drought injury and gradually dried up without maturing many heads except around the margins of the plat.

The first cutting was always made at a time when the crop was clearly too immature for good hay or at least for maximum yields; at this stage the young plants were still making vigorous growth and had not begun to head. The second and third cuttings followed at 2-week intervals, with drought injury gradually more marked, and the fourth cutting was made after the crop had definitely matured seed, dried up, or been frosted, so that no further growth was possible. The seedings were accomplished under excellent soil conditions in most seasons, the date ranging from May 23 to June 7, with May 31 the average. The average date of the first cutting was August 2, and for the other cuttings August 15, August 31, and September 24, respectively.

In only one case was there a second growth more than a foot tall; this was harvested from the plat used for the first cutting in 1920, and the product of the second growth was included in the yield of the first cutting for that year. As in all the other work reported from Hays, the hay yields were corrected by samples to an air-dry basis, and in the first three years, 1917 to 1919, samples of each cutting were sent to the Bureau of Chemistry, United States Department of Agriculture, for a determination of their composition.

The annual and average yields of hay, the average number of days from seeding to cutting, and the average height of the plants, are shown in Table 27.

TABLE 27.—*Agronomic data regarding close-drilled Red Amber sorgo when cut at different stages of maturity at Hays, Kans., in stated years.*

Cutting.	Stage of growth.	Yields of air-dry hay per acre (tons).							Average.	
		1917	1918	1919	1920	1921	1922	Average.	Growing season (days).	Height (inches).
First	Before heading	1.57	1.61	2.16	5.15	3.19	2.37	2.68	62	41
Second	Partially headed	1.97	2.07	2.95	4.13	3.34	3.13	2.93	74	46
Third	Bloom to dough	1.93	2.54	3.10	4.17	3.37	3.51	3.10	90	48
Fourth	Seed ripe	2.33	2.84	3.39	5.61	3.99	4.04	3.70	114	50

It will be noted in Table 27 that the yields ordinarily increase with the length of the growing season. Cutting as late as possible when the sorghum had completed its growth for the year produced 1 ton more hay per acre than cutting before the plants began to head. The quality of the hay from the second and third cuttings appeared to be the best, however, and all factors considered cutting at the third stage of maturity or a little later is probably the most practicable time for farm purposes.

It is well known that the chemical composition of plants varies with the stage of maturity. A study was therefore made to deter-

mine the composition of the sorghum hay from the different cuttings and also the total acre production of the different food elements. The results of this chemical study of the hay obtained from the different cuttings are shown in Table 28.

TABLE 28.—*Composition of hay and yield per acre on a moisture-free basis of the principal food elements of Red Amber sorgo when cut at different stages of maturity.*

Stage of maturity	Dry matter.	Ash.	Ether extract.	Protein.	Crude fiber.	Nitrogen free extract.
Composition (per cent):						
Before heading	100	11.92	2.18	12.75	39.97	33.18
Partially headed	100	11.67	2.13	11.28	35.08	39.84
Bloom to dough	100	10.84	2.19	11.03	27.97	47.97
Seed ripe	100	9.66	1.95	8.94	24.44	55.01
Yield per acre (pounds):						
Before heading	4,535	540	99	578	1,813	1,505
Partially headed	4,963	579	106	560	1,741	1,977
Bloom to dough	5,239	568	115	578	1,465	2,513
Seed ripe	6,209	600	121	555	1,517	3,416

The data in Table 28 show that there is a definite increase in the percentage of nitrogen-free extract as the sorghum approaches maturity and a corresponding though less pronounced decrease in the percentage of all the other principal food elements. When these percentages are applied to the average acre yields, the yields from the later cuttings are found sufficiently greater than the yields from the early cuttings to compensate for the smaller percentages of practically every element except the crude fiber. In everything except protein and crude fiber the yields are largest from the fourth stage of maturity and a deficiency in crude fiber is usually considered an advantage.

It is a matter of considerable convenience in farm operations that sorghum is not at all exacting in its requirements as to the time of cutting. Any loss in quality resulting from a delay in cutting is usually balanced by an increased tonnage.

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